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Land and Water Use Effects on Ground-Water Quality in Las Vegas Valley

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Land and Water Use Effects on Ground-Water Quality In Las Vegas Valley

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LAND AND WATER USE EFFECTS ON GROUND-WATER QUALITY IN LAS VEGAS VALLEY

by

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Grant No. R800946

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DEDICATION

Dr. George B. Maxey, an esteemed scholar and true friend, conducted and guided fundamentally important groundwater studies in southern Nevada for over three decades. His knowledge of groundwater occurrence, quality, and movement and his integration of geologic and hydrologic principles on local, basin and regional scales continues to permeate the theory and application of hydrogeology. In southern Nevada and especially in Las Vegas Valley, he was an unquestioned authority. His perception of science and people and his unwavering ability to conceive and implement responsive research programs are legend. With respect to the effort presented herein, he was intimately involved as a scientist, administrator, and above all, a cherished colleague whose encouragement, criticism and continual personal concern will always have my gratitude. His influence can best be fathomed and appreciated by those who had the pleasure to interact with him in the subject areas he so dearly loved. He was and is the rare being that one never forgets.

FOREWORD

Since the vast influx of population began poring into the Las Vegas Valley in the 1940's the hydrologic regime of the Valley has undergone significant change. The pristine environment of the Valley was desert with desert vegetation and no perennial flow out of the Valley. With increase in population came the proliferation of lawns, shrubs, and trees throughout the Valley. This domestic irrigation of vegetation together with wastewater return flows has created a perennial stream leaving the Valley through Las Vegas Wash. This study was implemented to determine what is happening in the shallow ground-water zone (0 to 300') within the Valley, its flow, and the main sources of contamination. Results of this study have been divided into three volumes, this publication, the first volume, deals with the problem of how ground-water quality is affected by land and water use throughout the Valley. Volume two entitled, "Las Vegas Valley Water Budget: Relationship of Distribution, Consumptive Use, and Recharge to Shallow Ground Water," gives a detailed picture of the input and outflow of the water being used in Las Vegas Valley. The third volume, "Simulation Modeling of the Shallow Ground-water System in Las Vegas Valley," discusses the problems and water level fluctuations in the shallow groundwater system.

These three volumes represent an assessment of the shallow ground-water system in Las Vegas Valley and should be of use to anyone dealing with that aspect of the hydrologic regime in Las Vegas Valley.

Gilbert F. Cochran
Acting Executive Director

ABSTRACT

The hydrogeologic study of the shallow ground-water zone in Las Vegas Valley, Nevada determined the sources and extent of ground-water contamination to develop management alternatives and minimize adverse effects. An extensive, computerized data base utilizing water analyses, well logs, head measurements, and surface flows was developed. Flow system analysis, gross chemical data and tritium analyses were used in combination with trend surface techniques to ascertain natural and contaminated ground-water quality to depths of 0 to 50, 51 to 100, and 101 to 300 feet. At depths below 100 feet, the distribution of all constituents reflects natural controls. Nitrate and chloride in the zone from 0 to 50 feet are closely related to waste disposal activities, chief of which are industrial effluent, treated sewage, and septic tanks. In addition, tritium is highly indicative of return flows associated with distribution of Colorado River water in the Valley. Localized contamination of shallow unconfined ground water and rapid appearance of return flows is accentuated by pronounced vertical hydraulic and stratigraphic boundary conditions present in the eastern and western parts of the Valley. Nonparametric testing of extremely limited historical water quality data to ascertain temporal changes, particularly for the very shallow aquifers, yielded generally insignificant results. This is believed due to the lack of data because changes are indicated by gross chemical, tritium, and water budget data. Although the rudiments of a monitoring program have been outlined, management objectives for shallow ground water are undefined by responsible agencies, thus complicating the reason(s) for monitoring and the level of effort required. Management of shallow ground water bears on valley-wide and regional water management objectives and will become increasingly important when nonpoint source return flows double or triple to about 80,000 to 120,000 acre feet per year in the next twenty to thirty years.

This report was submitted in fulfillment of Grant No. R800946 by Desert Research Institute under the sponsorship of the U. S. Environmental Protection Agency. This report covers the period November 1, 1969, to January 31, 1974, and work was completed as of December 31, 1976.

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METRIC-ENGLISH CONVERSION*

A. LENGTH:

Unit	Equivalent(a) (b)					
	millimeter	inch	foot	meter(c)	kilometer	mile
millimeter	1	0.039 37	0.003 281	0.001 000	1 E-6	0.621 4 E-6
inch	25.40	1	0.083 3	0.025 40	25.40 E-6	15.78 E-6
foot	304.8	12	1	0.304 8	304.8 E-6	189.4 E-6
meter(c)	1 000	39.37	3.281	1	0.001	621.4 E-6
kilometer	1 000 000	39 370	3 281	1 000	1	0.621 4
mile	1 609 000	63 360	5 280	1 609	1.609	1

[1] Footnotes for all parts of Table 5

(a) Equivalent values are shown to 4 significant figures.

(b) Multiply the numerical amount of the given unit by the equivalent value shown (per single amount of given unit) to obtain the numerical amount of the equivalent unit (e.g.; 5 inches × 0.025 40 m/inch = 0.127 0 m).

(c) This is the SI expression, in base units or derived units, for the physical quantity.

B. AREA

Unit	Equivalent(a) (b)						
	sq. inch	sq. foot	sq. meter(c)	acre	hectare	sq. kilometer	sq. mile
sq. inch	1	0.006 944	645.2 E-6	0.159 4 E-6	64.52 E-9	645.2 E-12	249.1 E-12
sq. Foot	144	1	0.092 90	22.96 E-6	9.290 E-9	92.90 E-9	35.87 E-9
sq. meter(c)	1 550	10.76	1	247.1 E-6	1 E-4	1 E-6	386.1 E-9
acre	6 273 000	43 560	4 047	1	0.404 7	0.004 047	0.001 563
hectare	15 500 000	107 600	10 000	2.471	1	0.01	0.003 861
sq. kilometer	1.550 E+9	10 764 000	1 000 000	247.1	100	1	0.386 1
sq. mile	4.014 E+9	27 880 000	2 590 000	640	259	2.590	1

C. VOLUME:

Unit	Equivalent(a) (b)							
	cu. inch	liter	U.S gallon	cu. foot	cu. yard	cu. meter(c)	acre-foot	sec-foot-day
cubic inch	1	0.016 39	0.004 329	578.7 E-6	21.43 E-6	16.39 E-6	13.29 E-9	6.698 E-9
liter	61.02	1	0.264 2	0.035 31	0.001 308	0.001	810.6 E-9	408.7 E-9
U.S. gallon	231.0	3.785	1	0.133 7	0.004 951	0.003 785	3.068 E-6	1.547 E-6
cubic foot	1 728	28.32	7.481	1	0.037 04	0.028 32	22.96 E-6	11.57 E-6
cubic yard	46 660	764.6	202.0	27	1	0.764 6	619.8 E-6	312.5 E-6
cubic meter(c)	61 020	1 000	264.2	35.31	1.308	1	810.6 E-6	408.7 E-6
acre-foot	75.27 E+6	1 233 000	325 900	43 560	1 613	1 233	1	0.504 2
second-foot-day	149.3 E+6	2 447 000	646 400	86 400	3 200	2 447	1.983	1

D. DISCHARGE (FLOW RATE, VOLUME/TIME):

Unit	Equivalent(a) (b)					
	gallon/min	liter/sec	acre-foot/day	foot³/sec	million gal/day	meter³sec(c)
gallon/minute	1	0.063 09	0.004 419	0.002 228	0.001 440	63.09 E-6
liter/second	15.85	1	0.070 05	0.035 31	0.022 82	0.001
acre-foot/day	226.3	14.28	1	0.504 2	0.325 9	0.014 28
foot³/second	448.8	28.32	1.983	1	0.646 3	0.028 32
million gallons/day	694.4	43.81	3.069	1.547	1	0.043 81
meter³/second(c)	15 850	1 000	70.04	35.31	22.82	1

E. VELOCITY:

Unit	Equivalent(a) (b)				
	foot/day	kilometer/hour	foot/sec	mile/hour	meter/sec(c)
foot/day	1	12.70 E-6	11.57 E-6	7.891 E-6	3.528 E-6
kilometer/hour	78 740	1	0.911 3	0.621 4	0.277 8
foot/second	86 400	1.097	1	0.681 8	0.304 8
mile/hour	126 700	1.609	1.467	1	0.447 0
meter/second(c)	283 500	3.600	3.281	2.237	1

* Taken from System International D'Unites, Metric Measurement in Water Resources Engineering, prepared for the Universities Council on Water Resources, June 1976.

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Many outside agencies and individuals provided financial and other support, including the U. S. Bureau of Reclamation and the Nevada Division of Colorado River Resources (formerly Colorado River Commission, CRC). Messrs. Arleigh West, former Regional Director for the Bureau and Donald Paff, Administrator for the CRC, helped place the study in perspective relative to the local and regional water quality management situation. The Bureau and CRC provided financial and material support for establishing the water quality laboratory and for an extensive water sampling effort on Lake Mead. Mr. Carl Dewey, U. S. Bureau of Mines also helped in the establishment of the laboratory. Financial support was obtained from the National Park Service through Mr. Roger Allin, Superintendent of the Lake Mead Recreational Area, and from the Fleischmann Foundation of Reno, Nevada. The A & K Construction Company donated five ground-water monitoring wells in the Las Vegas Wash area.

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SUMMARY OF CONCLUSIONS

RESEARCH OBJECTIVES

Intensive study of land and water use patterns and hydrogeologic conditions in Las Vegas Valley focused on defining water quality conditions in the shallow sediments to depths of 300 feet. Water quality in parts of the near surface system of aquifers and aquitards is greatly affected by urban and industrial land and water use practices, cheif of which are liquid waste disposal, overdraft of deeper aquifers, irrigation return flows, infiltration of overland flow, and disruption of natural soil conditions. The study also sought to establish the relationship between such land and water use patterns on basin wide water quality management, particularly the ground-water aspects.

With the physical setting established in terms of natural conditions and in relation to developmental patterns, the essentials of a water resources systems response monitoring strategy were identified to assist in long-term water quality management within the Valley and in relation to realities of Las Vegas Wash and Lake Mead pollution problems. Hopefully the knowledge gained will be a contribution having local importance. In a more general sense, the objectives and study techniques have wider applicability and relevance to the mandates for ground-water protection embodied in Public Law 93-523 (Safe Drinking Water Act).

AQUIFER FRAMEWORK AND PATTERN OF FLOW

Las Vegas Valley is an intermontane arid basin which contains a thick sequence of alluvial sediments arranged vertically and laterally in a complex system of aquifers and aquitards. The most permeable sediments are in the northwestern and west-central parts of the Valley where the principal volume of ground-water extraction has occurred to data, primarily from confined aquifers at depths of 250 to 1,000 feet. Except in the west-central area, these aquifers are overlain by extensive layers of poorly permeable clay, silt, or caliche. Separating these productive zones from generally less permeable sediments to the east is a series of faults and associated scarps which impede eastward ground-water flow. The eastern part of the Valley is characterized by primarily fine-grained sediments and a shallow water table.

Immediately west of the main scarp in Las Vegas Valley, the near surface zone consists of a thin layer of shallow alluvium underlain by extensive caliche and other aquitard materials. The alluvium grades westward into fan sediments and the zone is stratigraphically and hydraulically indistinguishable from the deeper aquifer. Northeast of the scarp there is no lithologic basis for separation of a near surface zone. In the southeastern part of

Las Vegas Valley, the near surface zone consists of saturated, unconsolidated sands and gravels ranging in thickness from 20 to 100 feet. This area is underlain by an unknown thickness of poorly permeable fine-grained sediments, probably belonging to the Muddy Creek Formation.

The near surface flow system is unconfined except possibly in a few very localized areas. It is in hydraulic continuity with underlying saturated sediments. Although perched water is locally present, it is not significant in the context of water resources management in the Valley or relative to the present study. Previous to ground-water development which effectively began in 1907 and constituted overdraft by the 1940's, recharge was principally by upward movement from underlying aquifers. Because of pumping from deep aquifers, the potential gradient in the near surface zone in the northwest subarea has been reversed, causing shallow ground water to move downward into underlying aquifers. In the southwest subarea, downward movement occurs principally in the vicinity of heavy pumping while in other parts of the subarea there is still upward movement into the near surface zone. In the northeast subarea there is probably little downward movement of ground water at depth. In lower Las Vegas Valley, ground water moves from the near surface zone into underlying sediments on upper parts of the fan near Henderson and the BMI industrial complex. In topographically lower parts of this area there is upward movement with discharge to Las Vegas Wash and(or) as evapotranspiration.

Under natural conditions, recharge to the valley fill was believed a result of precipitation in the surrounding mountains, primarily those to the west and north. Flow from the recharge areas via a deep aquifer system involved an easterly or southeasterly path incorporating lateral and then upward movement in the valley fill either as diffuse seepage or as localized flow towards springs discharging in close proximity to fault planes. There is some recent evidence that the recharge area may extend beyond the topographic basin and involve the deep-seated limestone strata to a greater degree than previously believed. Both the seepage and reinfiltration of the spring discharges resulted in recharge of the near surface zone, discharge from which was by evapotranspiration. There was no surface water flow of ground water from the Valley and the principal discharge areas such as the Meadows (Las Vegas) were well removed from the present locus of surface discharge, Las Vegas Wash.

NATURAL WATER QUALITY

Ground-water quality in the deeper part (101 to 300 feet) of the shallow zone largely reflects the combined influence of rock type, length of flow path, and the effects of decreasing permeability and increased residence time in an eastward direction along the flow path. Progressive increase in salt content along the flow path in the deeper part of the shallow system (depths of 101 to 300 feet) is a result of the aforementioned factors. These are also influential at very shallow depths (0 to 50 feet), but the principal influence on salt concentration is evapotranspiration.

Available chemical analyses of ground water for the period 1962 to 1968 for depth intervals 0 to 50, 51 to 100, and 101 to 300 feet were interpreted using trend surfaces and a large data base, consisting of about 4,000 water analyses cross-referenced to over 6,300 wells. This base was developed from existing records, and supplemented with additional analyses for gross chemistry and nutrients. Total dissolved soldis (TDS) in the depth interval from 101 to 300 feet increase in an eastward direction from 300 mg/ℓ on the western and northwestern fringes of the suburban area to 3,000 mg/ℓ in the vicinity of Las Vegas Wash. Variations in this interval are solely from natural causes which include the basic flow system configuration, the geologic matrix, and the position of the principal recharge and discharge areas in the Valley. Whereas the distance from the recharge area in the Spring Mountains to the 1,000 mg/ℓ TDS contour line is about 30 miles, dissolved solids increase from 1,000 mg/ℓ to 3,000 mg/ℓ in a distance of about four miles in the area of concentrated ground-water discharge. Gypsiferous sediments in the Paradise Valley area and adjacent to the Sunrise-Frenchman Mountain complex account for the rapid increase in sulfate and calcium in the southern and northeastern portions of the Valley. The effects of reduced permeability and consumptive discharge in these areas are additive. The trend surfaces for TDS at depths of 101 to 300 feet also infer that a previously undescribed and relatively undeveloped zone of good quality water trends eastward across the northern portion of the study area. Additional exploration will be necessary to substantiate this inference.

Nitrate[1] (as NO_3) and chloride concentrations at depths of 101 to 300 feet show little systematic variation. As a result of natural factors, chloride gradually increases from 10 mg/ℓ to 185 mg/ℓ near the area of ground-water discharge. However, nitrate at this depth remains in low concentration of about two to seven mg/ℓ throughout the area studied. Nitrate concentrations exceeding ten mg/ℓ are locally present, indicating that in localized areas sewage effluent has contaminated aquifers deeper than 100 feet.

Soil conditions have an important bearing on shallow ground-water management. The soils data and the recent study by Cooley et al. (1973), support the thesis that significant in-valley recharge by precipitation is small and probably is on the order of several thousand acre feet or less (Patt, 1977). In addition, the precipitated salts in surficial soils in the central portion of the Valley are both allogenic and authigenic, the latter originating as precipitation from ground water and/or former standing water bodies. Return flow from irrigation water and liquid waste disposal is likely to dissolve these constituents and increase the salinity of shallow ground water. Also, the presence of essentially impermeable but discontinuous caliche and hard pan layers near the land surface limits the available storage of return flows and diverts them laterally. Fine-grained soils present on interfluvial surfaces in much of the urban and suburban portions of the Valley are characterized by low infiltration rates and high salt content.

Minimal TDS concentrations occur in ground water associated with the granular, less mineralized soils present on the medial and distal portions of alluvial fans surrounding the urbanized areas and in the major drainage courses such as Duck Creek and Las Vegas Wash. Maximum concentrations occur in the central and southeastern areas underlain by finer-grained, mineralized soils, upward moving ground water, and evapotranspiration from near surface ground water. The combined effect of these three factors plus gradual enrichment along the flow path are evident from the steeper concentration gradient in the area surrounding the lower reach of Las Vegas Wash. Recharge by concentrated industrial wastes from the industrial complex in Henderson also accounts for abnormally saline ground water in those portions downgradient from the plant area and tailings ponds.

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[1] All nitrate data are expressed as nitrate

In general, ground water to depths of 50 feet is not potable because of high salt content. Where primary or secondary treated sewage effluent has been applied to the land surface, nitrate occasionally exceeds the commonly accepted limit of 45 mg/ℓ (as NO_3). Therefore, expanded use of wastewater for irrigation should procede with caution because of the deleterious effects demonstrated with respect to very shallow ground water and associated potential adverse effects on deeper aquifers. Use in areas with lateral or upward flow gradients is favored because hydraulic drive to transport contaminants to productive aquifers is absent. However, extensive application of wastewater in certain areas is likely to result in waterlogging and(or) development of a base flow component in area drainage. Extensive reuse of sewage effluent in portions of the western and northern sectors of the Valley is not recommended because deterioration of shallow, relatively high quality water could occur. Thick caliche layers and extensive clay and silt sediments at shallow depths favor lateral migration and local perching of return flows in much of the developed portions of the Valley. Without deliberate management renovative effects of local soil columns will decrease and noxious return flows may occur. In summary, additional hydrogeologic and sanitary engineering studies will be necessary to select areas for reuse and to monitor the effects.

EFFECTS OF LAND AND WATER USE ON SHALLOW GROUND WATER

Although in-valley precipitation is not an appreciable source of recharge to shallow ground water, infiltration of various return flows into the near surface aquifer as a result of water development has been going on continuously ever since 1907 when the first artesian wells were developed. Excess irrigation water infiltrated and many wells flowed freely until the mid to late 1930's when the work of Livingston (1938) prompted the State Engineer to require that abandoned wells be properly sealed and owners limit the discharge to beneficial uses. The present study shows that return flows from a variety of water and land use categories now amount to 46,000 acre feet per year (Patt, 1977).

Prior to extensive water use in the Valley, total ground-water outflow via Las Vegas Wash was estimated at about 250 acre feet per year. As a result of extensive industrial effluent disposal on the order of 11,000 to 17,000 acre feet per year from the early 1940's to date, ground-water discharge to the Wash in 1972 was about 12,000 acre feet and contributed roughly 60 to 70 percent of the measured salt flux leaving the Valley other than in flood flows. In the urban and suburban areas, extensive mesquite groves, stands of salt bush and tules have been removed and replaced with suburban sprawl and the ubiquitous green lawn. Former discharge (by evapotranspiration) of 25,000 acre feet per year has been replaced by ground-water recharge of 46,000 acre feet per year. This recharge is believed to: 1) go into storage in the near surface aquifer, 2) move downward to recharge overdrafted, formerly artesian aquifers, and 3) flow laterally toward Las Vegas Wash.

Recharge to the near surface zone now is mainly a result of lawn, golf course, and agricultural irrigation throughout the Valley and from sanitary and industrial waste disposal practices adjacent to Las Vegas Wash. Of the 143,000 acre feet of water delivered in the Valley during 1973, about 46,000 acre feet or 32 percent were recharge to the near surface zone (Patt, 1977). Of the total recharge in the Valley, about 27,000 acre feet were from irrigation and about 1,750 acre feet were from septic tanks. About 14,000 acre feet of recharge occurred in the Las Vegas Wash area as a consequence of municipal and industrial waste disposal and irrigation return flow.

Sewage effluents have freely infiltrated the near surface zone at numerous municipal and privately operated sewage treatment plants. In 1955 alone, 7,000 acre feet of effluent infiltrated in the eastern part of the Valley. Total recharge in the same year was 14,000 to 18,000 acre feet. Irrigation of alfalfa with sewage from 1955 to 1969 caused water levels to rise 14.6 feet or 1.04 feet per year. A severe waterlogging problem has been recognized in a farm area of about 1,200 acres irrigated with sewage. In 1973 there were over 5,000 irrigated acres in the Valley receiving 46,000 acre feet per year, only about 40 percent of which was consumptively used.

Available nitrate data clearly reflect the widespread addition of sanitary wastes from septic tank leachate and sewage effluent. In the southeastern part of the Valley, industrial wastes have caused extensive contamination. Return flows from areas irrigated with sewage effluent or infiltration of treated effluent from lagoons and outfall ditches have raised nitrate concentrations in native ground water. Locally, concentrations exceed the U. S. Public Health Service (1962) maximum recommended level to 45 mg/ℓ of nitrate. There is a coincidence of above background concentrations of nitrate in shallow ground water with known septic tank areas. The available analyses, taken from throughout the developed portions of the Valley containing septic tanks, indicate increased nitrate both at the top of the zone of saturation and within the shallow potable aquifers. Additional study is necessary to determine whether nitrate is locally widespread in the shallow aquifer or if it is appearing as leakage along well casings. The available data base is inadequate in terms of lateral and vertical control. Nitrate concentrations in very shallow ground water commonly exceed natural (background) values of 10 mg/ℓ, and occasionally this occurs within a few years after wastes are first introduced. For most of the Valley, concentrations are less than 45 mg/ℓ but occasional peaks of 50 to 70 mg/ℓ occur in some wells and constitute a health hazard.

The widespread occurrence of increased concentrations of tritium in shallow ground water is associated with known sources of recent recharge, thus underscoring the marked hydrologic response to urbanization, and particularly irrigation and waste disposal practices. Septic tanks, irrigation with sewage effluent, disposal of effluent by spreading on the land and industrial waste disposal to unlined ponds are the most significant sources. Contaminated return flows from the sources mentioned appear in ten years or less and, in the case of most sources, are persistent for an even longer time period after disposal ceases. Tritium is particularly apparent in shallow ground water in areas served by water derived wholly or in part from the Colorado River. In these instances, the shallow aquifer an average of 49.4 tritium units (TU) compared to 20 TU in the western half of the Valley, largely served by deep ground water containing 3 to 6 TU. Infiltration of overland flow either from storm events or as tail water from lawn irrigation in housing areas also contributes to chemical pollution and increased tritium concentrations in shallow ground water. Ground-water return flow from the BMI complex, which uses only Colorado River water that has undergone little dilution, contains 200 to 400 TU.

Five subareas of the Valley having similar hydrogeologic and water quality settings and patterns of water development were designated so the analyses within each area could be statistically tested for temporal change in water quality. With few exceptions, the testing procedures revealed no significant change in ground-water quality regardless of the time periods or areas considered in the Valley. Significant change in TDS and chloride occurred in the northwest part of the Valley where heavy pumping may have induced vertical or lateral inflow of more saline shallow ground water. The data base to assess temporal change is woefully inadequate, however.

DATA AVAILABILITY AND ANALYSIS TECHNIQUES

For three separate depth intervals or "slices", the use of trend surfaces and their associated statistical measures proved very useful for evaluating several hundred water analyses selected to depict the nature of lateral variations so as to clarify regional and local trends. By simplifying otherwise complex patterns of ion distribution, variations attributable to natural and man-related sources of water quality deterioration were identified. The influences of natural and man-related sources of pollution are most evident from the tritium, chloride and nitrate data and, to a lesser extent, from variations in TDS. Tritium and nitrate, in particular, were useful indicators of return flows associated with irrigation and effluent disposal.

Through 1967, only 412 analyses are available from wells ranging in depth from 8 to 1,700 feet to document ground-water quality over an area of 150 square miles. Previous scientific studies account for 156 analyses with the balance from the period 1964-1967 and, therefore, of limited historical significance. Forty-four percent of the data are from wells of unspecified depth, thereby reducing their scientific value. Only 2 percent of the analyses are from the interval 0 to 100 feet. For areas in the eastern part of the Valley where in places there is a rising water table from return flows, there are essentially no analyses for the unconfined aquifer. Large areas undergoing rapid suburban growth are essentially devoid of baseline water quality data, hence future water quality changes associated with ongoing development will be extremely difficult to assess.

An insufficient data base exists to define long-term trends in water quality with respect to both the deep and the shallow aquifers. Nevertheless, vertical downward movement of poorer quality water into the deeper aquifers on the western side of the Valley is indicated by static water level measurements and hydrologic budget analysis (Harrill, 1976), lumped parameter simulation modeling by Cochran and Wilson (1971), and the distributed digital simulation model of this study (Westphal, in prep.). The profusion of agencies involved in water quality management might lead one to conclude the historically weak effort in data collection is no longer a problem in Las Vegas Valley. However, with the exception of efforts by the water utilities with respect to municipal wells, ground-water quality data are not being collected and plans to do so are not evident. Considering the type and amount of data presently being collected, it is unlikely that a ground-water specialist of the future will have any added advantage in terms of a data base compared to that which now exists.

SHALLOW GROUND-WATER MANAGEMENT IMPLICATIONS

Management of water quality in a rapidly growing urbanized arid basin involves surface water and ground-water components. In the southwest there commonly is overdraft of ground water and, subsequently, importation of surface water to meet increasing demands. Return flows associated with water usage recharge shallow aquifers. Hydrologic effects are often pronounced because natural hydraulic equilibrium is severly disrupted and a host of water quality impacts are realized, some of which are adverse.

Results of the water budget phase of this study (Patt, 1977) indicate that recharge of the near surface aquifer from in-valley water use amounted to about 38,500 acre feet in 1973. By comparison, the estimated total flux of ground water under predevelopment conditions ranged from 21,000 to 35,000 acre feet per year. Water demands have steadily increased, particularly in the last 30 years. Overdraft of the deeper, artesian aquifers probably began in the 1940's when pumpage exceeded 40,000 acre feet per year. More recently, pumpage approached 88,000 acre feet per year or roughly a 3 or 4:1 overdraft. Increasing amounts of Lake Mead water, first used in the Henderson area in the 1940's and in the eastern part of Las Vegas in the late 1950's, have reduced the use of ground water to about 73,000 acre feet per year in 1975. Planned water use in the Valley for Lake Mead water will be as much as 350,000 acre feet per year. Aside from the fact that Lake Mead water has about twice the TDS of ground water most widely used, there likely will be pronounced changes in return flow quantity associated with a water budget which is at least a ten-fold increase over predevelopment conditions. This study has demonstrated that important hydraulic and water quality changes have already occurred in the area of Las Vegas Wash.

Development of Las Vegas Valley has been and probably will continue to be rapid. Principal long-term water planning efforts in the past have focused on provision of adequate water supplies, and to a considerably lesser extent, on secondary treatment of sanitary wastes. Essentially no concern or action has been shown with respect to nonpoint sources of return to the shallow aquifers or to ground-water impacts on wastewater management and vice versa. Despite the expenditure of several million dollars for water quality management planning, recognition of the ground-water resource and its active and passive roles in these planning objectives is not yet evident in any comprehensive program.

Deep ground-water quality is related to overall water quality management in several ways. It has long been known that the best quality water already developed or potentially availabile in the Valley is from the deeper aquifers. Therefore, improved knowledge of this resource and the factors which may result in changes in quality, particularly adverse changes, are of importance. Secondly, it is apparent that overdraft of ground water has largely been a local phenomenon with the result that large areas of the Valley have potable ground water that is largely underdeveloped. With increasing distribution of Lake Mead water and a stated management objective of annual ground-water pumpage reduced to 50,000 acre feet per year, the trend toward underdevelopment is likely to continue and even increase. At some future time, estimated to occur in the period 1990 to 2000, Las Vegas Valley is expected to again face a potential water shortage. Beside importation of ground water from other valleys and in-valley water conservation programs, moderate ground-water mining on a much more distributive basis than at present is also an alternative to help meet future water demands and to maximize the use of high quality ground water. Maintenance of this option necessitates that preservation of existing high quality ground water be a prime consideration in the adoption of a water quality management program in the interim.

Documentation of ground-water quality conditions necessitates continued collection of water samples from the principal production zones throughout the Valley and from very shallow or near surface zones. Although the latter are not presently considered a prime resource, their continued neglect may render them a liability to other water quality management goals. The ground-water monitoring network developed in the course of the study, in conjuction with the data storage and retrieval system, has potential value for future ground-water quality investigations. This network and data system is the beginning of a program but should not be considered adequate on a valley-wide basis or in terms of potential water management objectives.

PROBLEM AREAS OF SHALLOW GROUND-WATER MANAGEMENT

Overland flow as sheet runoff plus flooding via diffuse systems of dry wash channels removed much of the surficial accumulations of salt during geologic time. With urbanization, drainage courses are improved, sheet flow is reduced or eliminated and recharge from return flows constitutes the net moisture flux through the soil profile. At present, salt removal is restricted to the wash flood plains, which are being reduced through channel improvement, and to selected areas where sheet flow is still possible; the expected impact of these trends is increased ground-water return flow and decreasing water quality.

Use of wastewater in an arid zone urban environment characterized by marked vertical boundary conditions and upward flow gradients results in the widespread contamination of shallow aquifers and relatively rapid emergence of return flows in surface water courses and as a contaminated veneer at the water table. Past disposal of liquid wastes to unlined ponds near Henderson has been unsuccessful for the most part. Although at least 230,000 acre feet of water have been disposed of to date, storage calculations show retention of only 3 to 6 percent of the amount infiltrated which is conservatively estimated at forty percent. Thus, true waste containment has been minimal and, environmentally, the disposal scheme is a failure insofar as wastes have migrated extensively into adjacent surface water and ground-water resources over an area of about 16 square miles. In response to an

EPA enforcement action, Stauffer Chemical Company and Montrose Chemical Corporation of California (1972) estimated that the cost of recovery and impoundment of wastes in the subsurface as well as anticipated future waste volumes would be $107,000,000. Noticeable reduction in flow volume and salt flux is expected to take years, and several decades are necessary before marked change in the total salt flux from ground water will occur after the disposal practice is terminated. In retrospect and in looking toward the future, such massive waste disposal operations must be critically examined relative to basin water quality management objectives and the spirit and letter of the Safe Drinking Water Act as it relates to ground-water protection.

Recharge originating as industrial and sanitary wastes and nonpoint sources of urban and agricultural return flows cannot migrate downward in the discharge portion of a ground-water flow system; they are not safely contained. Lateral migration is also necessarily short and the wastes typically reappear in the natural discharge areas on the Valley floor. Effluent disposal by surface spreading in the discharge portion of the flow system may conflict with other land uses if wastes are transported to the land surface. To minimize environmental impact, extensive liquid waste disposal in discharge areas should occur in lined, impermeable basins where evaporation to dryness occurs. Solid residues should then be safely landfilled or, possibly, recycled. Alternatively, recharge areas can be used to dispose of sanitary wastes to allow dilution and other processes to reduce or eliminate waste toxicity. Careful planning is essential to determine the extent and acceptability of effects on other existing and future water uses if this alternative is followed. Toxic wastes produced in the minerals processing industry are not generally amenable to disposal in this manner and complete containment becomes necessary.

Recharge to the shallow aquifer in the Valley proper has clearly increased with time. Annual accretion in 1943 was 21,000 acre feet compared to 26,650 acre feet in 1958, 27,600 acre feet in 1965, and 38,500 acre feet in 1973. Recharge to the shallow system now exceeds the total water budget for the Valley prior to settlement. Inefficient lawn watering accounts for much of the recharge to the near surface zone. If present water and land use patterns prevail, recharge associated with a future population of 750,000 may approach 75,000 acre feet per year, or roughly three times the total water flux prior to development. More efficient irrigation could reduce the present water demand by 15,000 acre feet per year and reduce annual return flows by 11,000 acre feet.

Generally speaking, however, it is probable that important changes in urban water use practices require institutional modifications and economic incentives. A poll of valley residents by Reichert and Leland (1971) indicated that price increases will probably result in reduced water usage, particularly uses outside the dwelling. Fitzsimmons (1973) concluded that tripling in water rates would be necessary to markedly reduce water demand. With increased unit prices for potable water and wastewater treatment, per capita water demand may decrease. However, total return flows can be expected to increase as a result of increased urbanization unless marked changes in landscaping practices are instituted.

MONITORING IN RELATION TO SHALLOW GROUND-WATER MANAGEMENT

This work clearly indicates the complexity of the shallow ground-water system in terms of existing character, past and present impacts of water development, urban land use, and various types of wastewater disposal and return flow impacts. Understanding of the shallow ground-water zone, while incomplete in some respects, is sufficiently detailed to allow qualitative estimation of likely responses to changing water and land use practices in the Valley. Although subtle and largely invisible, the present and potential importance of shallow ground-water problems necessitates their consideration in terms of hydraulic and water quality responses stemming from land and water use or waste disposal in the Valley. Considering projected water supply demands and expected uses (more than 350,000 acre feet per year, or over twice present water use) and the hydraulic and water quality responses documented herein, there is every reason to believe that shallow ground water will become increasingly relevant to basin wide water management.

If the foregoing is accepted, several options can be incorporated in management policy for the shallow ground-water zone:

1. Controlled wastewater disposal (this has been the actual practice in many parts of the Valley for industrial, municipal, and domestic wastewaters).

2. Further development of municipal or domestic water supply (this too, has been actual practice up to the present time in extensive areas of the Valley).

3. Development of supplemental water for irrigation and industrial purposes (where quality permits and economic development is feasible).

4. Stabilize, reduce or elimate saline ground-water effluent to Las Vegas Wash.

The above options illustrate possible management directions, each of which require monitoring programs and return flow management.

Unfortunately, it is unrealistic to specify a detailed shallow ground-water monitoring program including such specifics as well location, design, sampling intervals, etc., until basin wide water management policies are clearly defined, and wastewater disposal practices consonant with the basin wide water management policies are outlined. There is no general policy direction which indicates the uses to be made of the shallow ground-water system, and there is uncertainty with respect to development schemes for production aquifers in some parts of the Valley. Also unclear is the policy and management of return flow of water to the Colorado River in terms of amounts and quality constraints. Despite the foregoing uncertainties, the following known or extremely likely activities will affect shallow ground water and, therefore, influence the context of any monitorining program: 1) continued in-valley use of potable water for lawn irrigation, limited agriculture, evaporative cooling, etc., 2) sewage treatment and discharge in the Las Vegas Wash area, 3) limited reuse of sewage for golf course irrigation, 4) overdraft of the deeper aquifers, 5) continuation of present land and water use patterns (excepting large scale industrial waste disposal), and 6) increasing use of Colorado River water.

In addition to the above, it is expected that shallow ground-water resources will be intentionally and increasingly used for both waste disposal and as a source of water supply for such nonpotable uses as cooling water or irrigation. Use should fully reflect the nature of the local geologic framework with respect to ground-water quality and availability and any impacts on wastewater reuse.

An objective of this study has been development of a shallow ground-water monitoring program to furnish data for assessing the hydrogeologic effects of various water management plans developed for the Valley and particularly as they bear on return flows to Las Vegas Wash and Lake Mead. In part this has been achieved through definition of the principal problems and demonstrating the objectives and methodology for data collection, as well as data reduction techniques. The following items of consideration, in terms of water quality and associated fluid potential data from sampling points of known characteristics, are believed basic to a shallow ground-water monitoring program in Las Vegas Valley:

1. The three-dimensional chemical state of the system should be established through properly distributed water sampling points.

2. Individual sampling points should consist of fully cased and properly sealed wells, some of which are piezometers and open to a small or discrete portion of the system whereas others should be high capacity wells open to relatively large production intervals.

3. Wells should be sampled at set time periods and maximum effort should be made to maintain sampling points.

4. Shallow ground-water return flows should be sampled by means of natural springs/seeps and through interception of shallow zones of high permeability (buried wash channels?).

5. Known areas of recharge from lawn watering, golf course irrigation, and sewage/industrial waste disposal are particularly significant sources of contamination and should be monitored.

6. Monitoring of shallow and underlying aquifers in areas of wastewater reuse should precede, accompany and follow such reuse.

7. The monitoring programs of existing agencies should be carefully reviewed to increase efficiency and information returns. It is particularly important that information concerning well depths and sampling depths be collected as part of ground-water sampling programs.

8. The monitoring program should be amplified where and when needed to answer specific questions alternative management proposals raise with changing concepts and patterns of land and water use.

All data should be reasonably representative of a common time frame. This could be achieved by maintaining continuous water level records at a few selected representative locations plus measurements collected throughout the Valley and at least once during each period of maximum and minimum demand each year. Methods of measurement should be accurate and datum elevations should be surveyed, rather than estimated or assumed.

To obtain information about vertical hydraulic gradients, piezometer nests should be installed and maintained at selected points throughout the Valley. Obvious places are near pumping centers, in the vicinity of selected housing developments, and near selected golf courses. Piezometers should be installed so that distribution of hydraulic potentials in the vertical section can be determined during construction.

At present, such fluid potential data are essentially nonexistent in most of the Valley, and are key to relating water quality changes in underlying production aquifers to the shallow ground-water zone.

RECOMMENDATIONS

GROUND-WATER MONITORING

Recommendation I

Formulation of monitoring objectives and implementation of a monitoring program should directly stem from the broader objectives for management of ground-water resources in the Valley. Because of the close relationships between shallow ground water, land use, water use, and nonpoint return flows, state and local agencies having authority and responsibility in these areas should necessarily formulate these broad objectives. In addition, these must be in consonance with regional water quality management goals established by Federal authority; of particular importance is salinity control on the Colorado River.

There is strong justification developed in this work for adopting a monitoring program to provide useable data for evaluating the state of the shallow ground-water system with respect to 1) water quality, 2) water table (storage) fluctuations, 3) response in terms of surface discharge from the Valley, and within the Valley, and 4) responses in terms of quality change influenced by water transfer from shallow, low quality zones to deeper production zones.

Recommendation II

Findings of the present study indicate the following considerations are most relevant to formulation of management objectives for the shallow ground-water resource in Las Vegas Valley:

1. Existing state of the system as documented by this study, and the types and magnitudes of pollution and hydraulic impacts stemming from activities in the Valley;

2. Wastewater disposal requirements of the future, and the mandate of salinity control for the Colorado River Basin;

3. Continually increasing water supply demands, development, and proportional generation of return flow wastewaters;

4. Development of an adequate data base for management schemes involving the shallow system (i.e., uses for water supply or waste disposal);

5. The basic role the shallow ground-water zone takes in the generation of saline water return flow to Las Vegas Wash;

6. The time lag response of this system to external stress (lead time in planning for system responses is important); and

7. The great paucity of useable data to relate and predict probable responses to external stress.

In summary, the policy and management approach must integrate both water supply and wastewater disposal within the physical framework of the resource, as outlined herein and in relation to the objectives and constraints posed by Colorado River-Lake Mead salinity/eutrophication problems. The paucity of information on temporal responses and associated rates of change suggest that, at the very minimum, a valley-wide general monitoring program should be maintained that specifically address the shallow ground-water system as outlined above.

Recommendation III

The ground-water sampling program of the District Health Department should be continued and, if possible, repeated for areas identified in this study as having high nitrate problems. Cross-referencing of water analyses and drillers' logs, preferably using computerized storage and access, is highly recommended.

The presence of nitrate in ground water at depths of 101 to 300 feet may be related to improper well construction, particularly due to emplacement of gravel packs and(or) perforated intervals open to shallow saturation where nitrate concentrations reflect waste disposal practices.

Recommendation IV

Continued use of septic tanks and present or planned irrigation of green areas with treated sewage effluent should be accompanied by local ground-water monitoring programs to document changes in quality and storage. Use of sewage effluent in areas with near surface caliche layers or in areas with permeable gravels, both conditions commonly being present in the western part of the developed area, are not recommended.

WATER SUPPLY

Recommendation I

Feasibility studies should be conducted to determine if the area of relatively good quality ground water in the northeastern part of the Valley can be more fully developed. Secondly, the cause(s) of nitrate contamination in this area should be documented and corrective action taken.

Recommendation II

Throughout much of the Valley, investigations should be made to evaluate the shallow ground-water zone in terms of potential water supply for such purposes as irrigation or industrial supplies. Continually increasing water demands and use, coupled with problems of rising water tables and increased return flows of poor quality shallow ground water to Las Vegas Wash, indicate that one management alternative may involve concentrated development of this potential supply for selected uses. Present knowledge of quality should be supplemented by additional exploratory work, including test drilling, to develop information on well design, spacing, water quality, and potential yields.

WASTEWATER MANAGEMENT

Recommendation I

Economic and technical feasibility studies should be initiated to evaluate locations, assimilative capacity, and long-term effectiveness of salinity control through use of phreatophytes for consumptive use of saline wastewater introduced to the shallow ground-water zone.

INTRODUCTION

RESEARCH OBJECTIVES

Projections indicate Clark County population will double in about ten years (Boyle-CH_2M, 1969a). This growth is placing new demands on water supplies to sustain present use patterns. The quality of these supplies, as well as the quality of the return flows to both Lake Mead and the ground-water reservoir, need to be considered if comprehensive water quality management is to accomplished.

The overall study was designed to quantitatively determine the effects of past water use on ground-water occurrence and quality in Las Vegas Valley and provide a basis for projecting both physical and hydrochemical changes which are likely to result from increasing water utilization in the area. Of particular importance was the development of an improved understanding of the effects of water importation into a desert basin. The present report focuses on water quality aspects whereas reports by Patt (1977) and Westphal (1977) address quantitative changes in the shallow zone water budget and digital modeling thereof, respectively.

Water quality deterioration in Las Vegas Valley is attributable to natural, hydrogeologic factors and to land and water use patterns. Impact of these on basin wide water quality management is significant and will require increased consideration in the future.

Some of the more important effects recognized or suspected to date include:

1. An increase in TDS content of waters used in the area.
2. Increased return flows due to application of water to lawns, recreational areas and commercial crops.
3. Leaching of soluble salts from the soil profile to shallow ground water.
4. Alteration of ground-water potentials, thereby increasing discharge into Las Vegas Wash and downward movement of shallow, mineralized ground water into deeper aquifers heavily developed for water supply purposes.
5. Industrial waste return flows are adversely affecting the water quality in Las Vegas Wash.

The water quality section of this research effort has the following objectives:

1. Define the nature, extent, and cause of poor quality ground water in the shallow parts of the Las Vegas Valley ground-water system.
2. Demonstrate the interface between land and water use patterns and ground-water quality in relation to comprehensive basin wide water quality management.
3. Develop a water resources system response monitoring program designed to furnish appropriate hydraulic and chemical data to assist in maintaining ground-water quality in Las Vegas Valley.

METHOD OF STUDY

Field-oriented hydrogeologic techniques and development of a data bank from existing records encompassed the major thrust of the data collection and interpretation effort. In addition, more than 2,300 water samples were analyzed over a four year period for gross, trace, and nutrient constituents. Efforts in the first two years focused on the foremost industrial and sanitary sources in terms of effluent volume and quality and likely adverse impacts on surface water and ground-water resources. The Basic Management Inc. (BMI) industrial complex is adjacent to the Las Vegas Wash and wastes are primarily from metal and mineral processing plants and chemical manufacturing. Other major industrial effluent sources include cooling water from two power plants and two gravel washing operations. Municipal wastes from four separate sewage treatment plants also are tributary to the Wash.

Ground-water quality was determined by installation and sampling of approximately 55 new wells for areas or depths where data were lacking and by organizing analyses by the District Health Department. To obtain additional information such as static water levels and stratigraphic conditions, analyses were cross-referenced to driller logs from more than 6,300 wells in the Valley. This data bank of water analyses and well logs (not included herein) is probably the most comprehensive data base available for stratigraphic and hydrologic information concerning Las Vegas Valley. Tritium data were developed and extensively utilized to identify return flows resulting from urbanization and industrial water use.

To establish time-series data for ground-water quality, the sampling program included reentry to wells sampled in the mid-1940's and mid-1960's. If the original wells could not be located or had been destroyed, nearby substitute wells with similar completion characteristics were selected.

The trend surface analytical technique, in conjunction with the data bank, was implemented to reduce and portray extensive water quality and well log data. Manual retrieval of analyses and logs and cross-referencing would have been extremely inefficient considering the numbers available. Trend surfaces have the attribute of portraying broad, overall trends rather than detailed but complex variation of raw data. Statistics such as the correlation coefficient relate how well the surface fits the raw data and therefore provide a measure of how well the trends estimate spatial variability for the system and parameter considered.

HYDROGEOLOGIC FRAMEWORK AFFECTING RETURN FLOWS

INTRODUCTION

Las Vegas Valley is a major topographic depression covering 350 square miles in southern Nevada. The area of study is shown in Figure 1. The Valley trends northwest-southeast and is situated along the Las Vegas shear zone characterized by intense structural deformation, primarily consisting of right lateral movement (Longwell et al., 1965). Along this zone extensive erosion of bedrock units created a basin at least 3,000 feet deep in the central part of the Valley. Basin development by structural displacement associated with normal faulting is also probable but evidence is scarce. Faults downthrown to the east are present in the valley fill. Filling the bedrock depression are thick deposits of sand, gravel, silt, and clay which generally are coarsest toward the mountain fronts, becoming finer-grained toward the lower portions of the Valley. These were deposited by ephemeral streams originating in the highlands. Silt and clay deposits occupy the central portion of the Valley.

Mapped surficial deposits (Price, 1966; Bingler and Luza, in press; Dinger, in press) consist of alluvial sediments underlain by late Pleistocene (Wisconsinan) pond/marsh deposits that lie on top of and are interfingered with Pleistocene fan and playa sediments. Maxey and Jameson (1948) believed the foregoing were deposited in a large, ancestral valley eroded into the Muddy Creek Formation which is largely composed of fine-grained lake and alluvial sediments. The latter partly fills the large erosional basin developed in the bedrock strata affected by the shear zone. Sediments mapped as Muddy Creek Formation (Longwell et al., 1965) are exposed along the southern edge of Frenchman Mountain and the eastern edge of Whitney Mesa. They are unconformably overlain by surficial sands and gravels. The best exposure of the Muddy Creek sediment crops out in the Whitney Mesa area and consists of a sequence of red to pink clays and silts often more than twenty feet thick.

Extensive ground-water development is primarily from the Pleistocene valley fill and possibly from coarse-grained facies of the Muddy Creek Formation which may be present in the western part of the Valley. At present, essentially no use is made of ground water in the very shallow deposits and associated caliche strata, or the underlying bedrock units, because of inadequate permeability, excessive depth to water, and/or poor water quality. Extensive ground-water discharge as evapotranspiration and surface water discharge occurs in the Las Vegas Valley Wash area which encompasses about 30 square miles and is located generally between East Las Vegas and Henderson and between Las Vegas Wash and the BMI industrial complex.

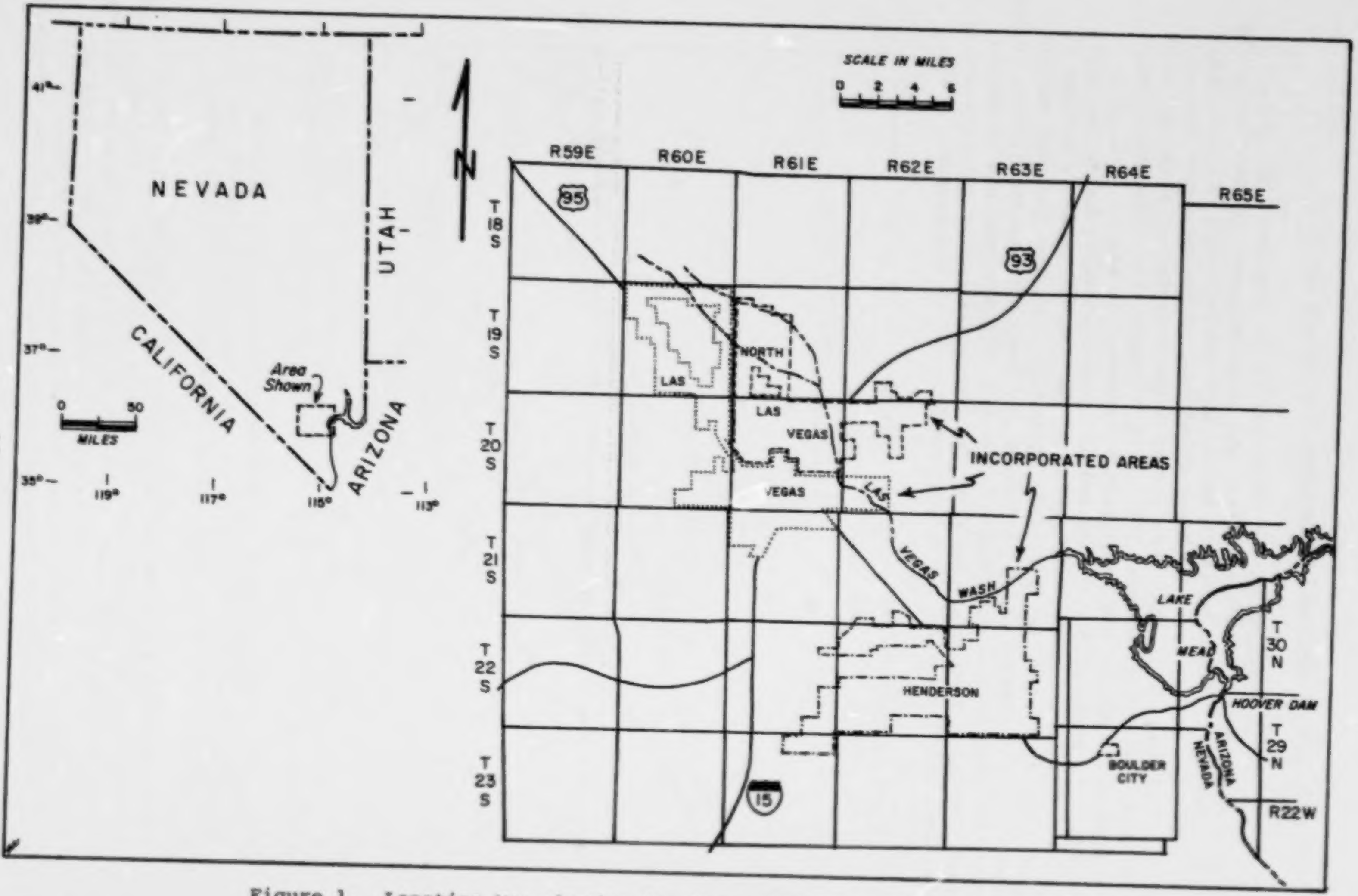

41°
39°
37°
35°
119°
117°
115°
113°
NEVADA
UTAH
CALIFORNIA
ARIZONA
Area Shown
0 50
MILES
N
SCALE IN MILES
0 2 4 6
R59E
R60E
R61E
R62E
R63E
R64E
R65E
T 18 S
T 19 S
T 20 S
T 21 S
T 22 S
T 23 S
95
93
15
NORTH
LAS
LAS
VEGAS
VEGAS
LAS
INCORPORATED AREAS
VEGAS
WASH
HENDERSON
BOULDER CITY
LAKE
MEAD
HOOVER DAM
ARIZONA
NEVADA
T 30 N
T 29 N
R22W

Figure 1. Location Map showing Las Vegas Valley and the study area.

PRINCIPAL FEATURES OF SHALLOW GROUND-WATER OCCURRENCE AND USE

Disposition of aquifers in Las Vegas Valley is schematically shown in Figure 2. In some parts of the Valley, the predevelopment pattern of upward movement from the confined aquifers to the near surface zone has been modified in the last thirty years by heavy withdrawal of ground water from the middle zone of aquifers. This zone occurs between depths of about 450 feet and 750 feet (Maxey and Jameson, 1948). As a result, the piezometric head in the confined aquifers has been greatly lowered. It was 60 feet above land surface in parts of the Valley and it is now generally below the level of water in the near surface zone, which in the present study is defined as the upper 300 feet of valley fill and, therefore, includes the near surface and (part of) the shallow zones as defined by Maxey and Jameson (1948). Prior to extensive ground-water development, the near surface zone was recharged by upward movement from the underlying confined zones and by infiltration of spring flows originating in the deeper aquifers (Maxey and Jameson, 1948).

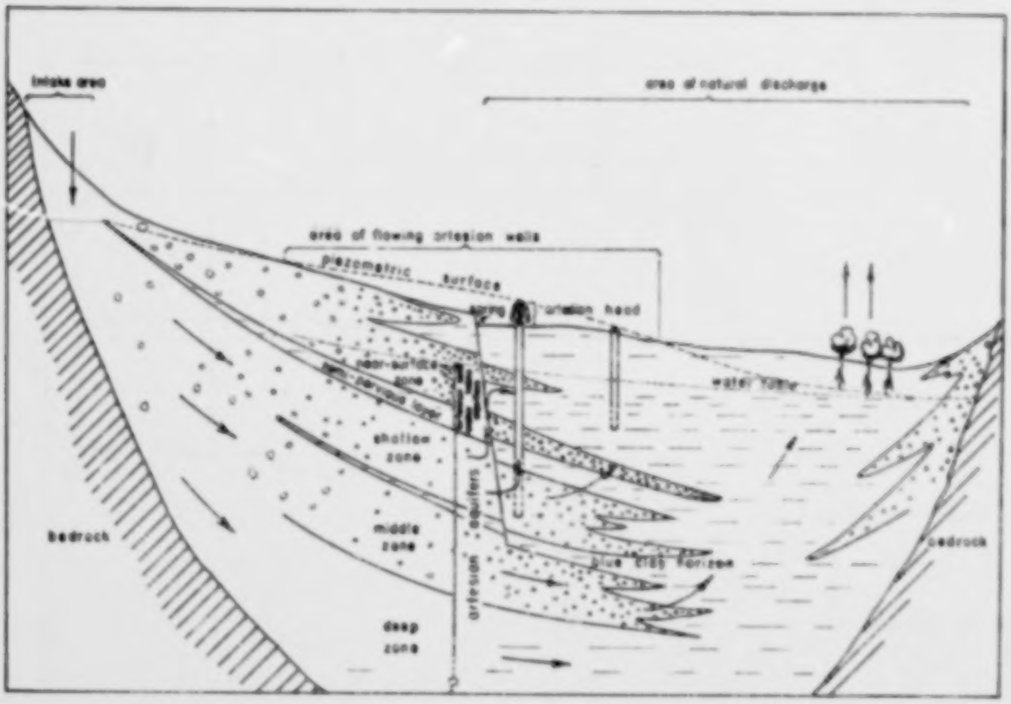

intake area
area of natural discharge
area of flowing artesian wells
piezometric surface
spring
artesian head
water table
near-surface zone
semi-pervious layer
shallow zone
middle zone
deep zone
artesian aquifers
blue clay horizon
bedrock
bedrock

Figure 2. Generalized east-west hydrogeologic cross-section showing ground-water occurrence and flow prior to extensive development (Malmberg, 1961, based on Maxey and Jameson, 1948).

A large marshy area known as "Las Vegas" was centered about Las Vegas Creek forming an area of approximately eight square miles. A shallow water table recharged by upward movement also was present in the Duck Creek drainage, along the upper reaches of Las Vegas Wash and along the lower reaches of Flamingo and Tropicana Washes. Other discharge areas were present in the areas of Tule Springs and the Gilcrease Ranch, both in the extreme northwestern corner of the study area. In effect, discharge by evaporation and evaportranspiration equaled recharge by infiltration and upward movement and the near surface zone was in equilibrium, with no surface flow leaving the Valley. Beginning in the mid 1940's, this natural predevelopment condition underwent rapid and dramatic change. Upward movement and spring discharge was greatly reduced as a result of gradually increasing overdraft of the deeper (middle zone as defined by Maxey and Jameson, 1948) aquifers, particularly those in the western and northwestern portions of the suburban area. Whereas there has been widespread reduction in artesian head, dewatering of shallow sediments has only occurred in a north-south trending belt on the western edge of the developed area in the Valley. In the last 30 years, the near surface zone as defined herein has been, for the most part, the locus of increased recharge from surface sources and decreased discharge as a result of phreatophyte removal. Patt (1977) describes the changes in the near surface zone water budget from 1943 to 1973.

Principal natural and cultural features bearing on the occurrence and quality of shallow ground water in Las Vegas Valley are shown in Figure 3. Fault scarps oriented generally north-south are geologically young but predate man's presence in the Valley. Whitney Mesa and extensions of this lineament to the north are perhaps the best surficial expressions of this faulting (Figure 4). These delineate the transition from fine-grained sediments to the east and coarser materials to the west. Lateral, eastward ground-water movement is impeded by a decrease in transmissivity in the fault zone areas. The largest springs in the Valley, most of which ceased to flow in the late 1940's and early 1950's, are generally located in close proximity to the scarps. This is indicative of loss of transmissivity and conduit development associated with the fault zones. Under natural conditions prior to heavy pumping, these springs were characterized by very stable flow, water quality, and temperature indicative of a deep-seated source. The springs are now dry as a result of heavy pumping and reduced upward movement. Shallow ground water on the order of 100 feet or less, commonly appears to accumulate in the upthrown block and "weep" across an exposed scarp face. This is a manifestation of extremely low permeability of fine-grained surficial sediments and pronounced boundary conditions exerted by near surface caliche layers, common in the western two-thirds of the Valley (Figure 5).

The areas of principal ground-water development and amount of production for public water supply are shown in Figure 3. Principal public water supply developers include the Las Vegas Valley Water District, North Las Vegas, and Nellis Air Force Base. A second major user group, the resort industry, is centered on the Las Vegas Strip and involves extensive development to support lawn irrigation and other recreational uses.

As a result of return flows from nonpoint sources and from industrial and sanitary waste discharges, an extensive high water table has developed in the eastern part of the Valley particularly in the Las Vegas Wash area (Figure 6). Because the prevailing ground-water flow direction is eastward toward the lowest point in the Valley, saline, nutrient-laden ground water surfacing along Las Vegas Wash constitutes a significant baseflow component to surface flows and necessitates joint consideration of surface water and ground-water factors in basin wide water quality management.

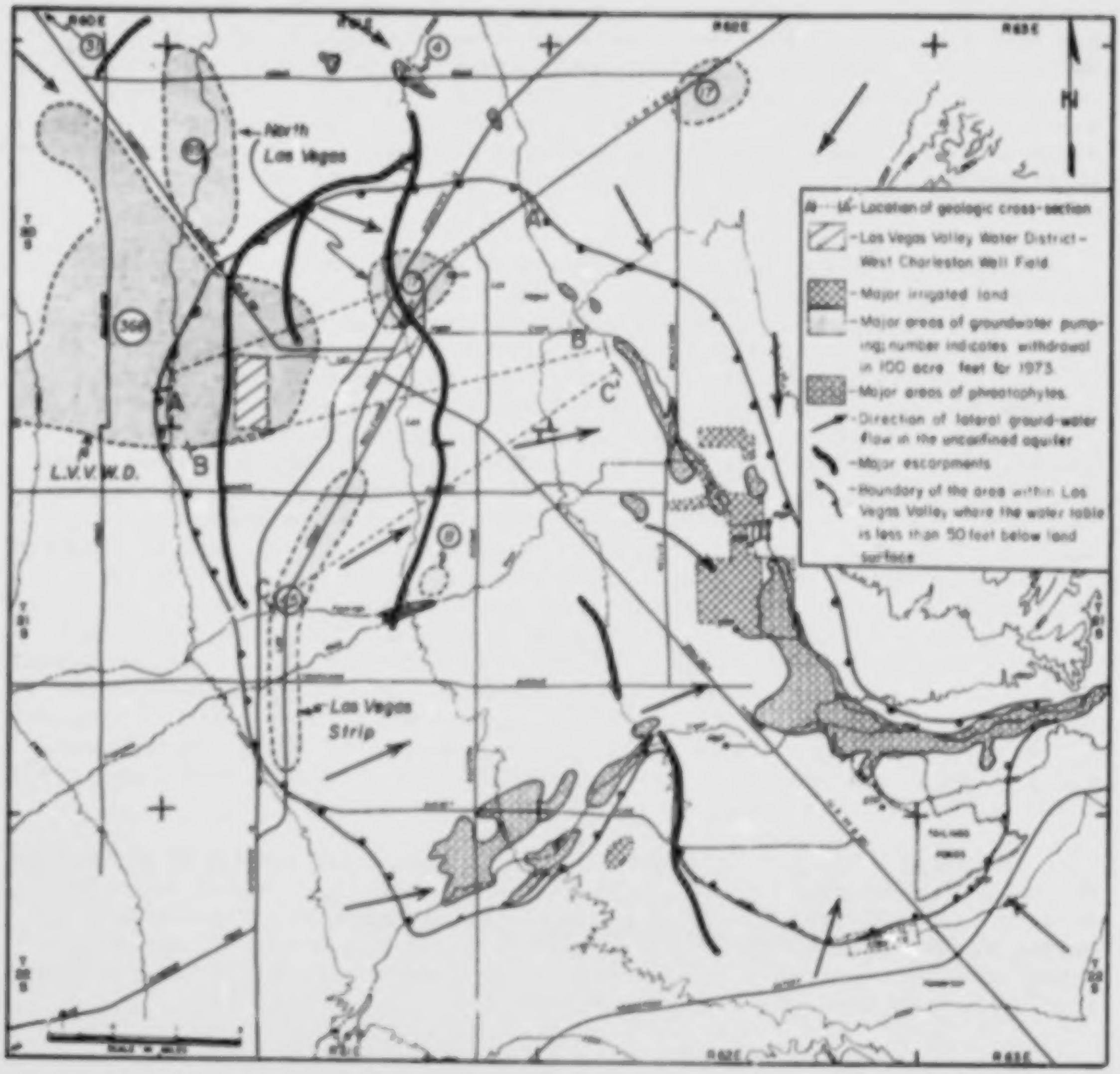

North Las Vegas
L.V.V.W.D.
Las Vegas Strip
A
A'
B
B'
C
C'
N
Location of geologic cross-section
Los Vegas Valley Water District - West Charleston Well Field
Major irrigated land
Major areas of groundwater pumping; number indicates withdrawal in 100 acre feet for 1973.
Major areas of phreatophytes.
Direction of lateral ground-water flow in the unconfined aquifer
Major escarpments
Boundary of the area within Las Vegas Valley where the water table is less than 50 feet below land surface
R 60 E
R 62 E
R 63 E
T 20 S
T 21 S
T 22 S

Figure 3. Principle features of ground-water occurrence and development.

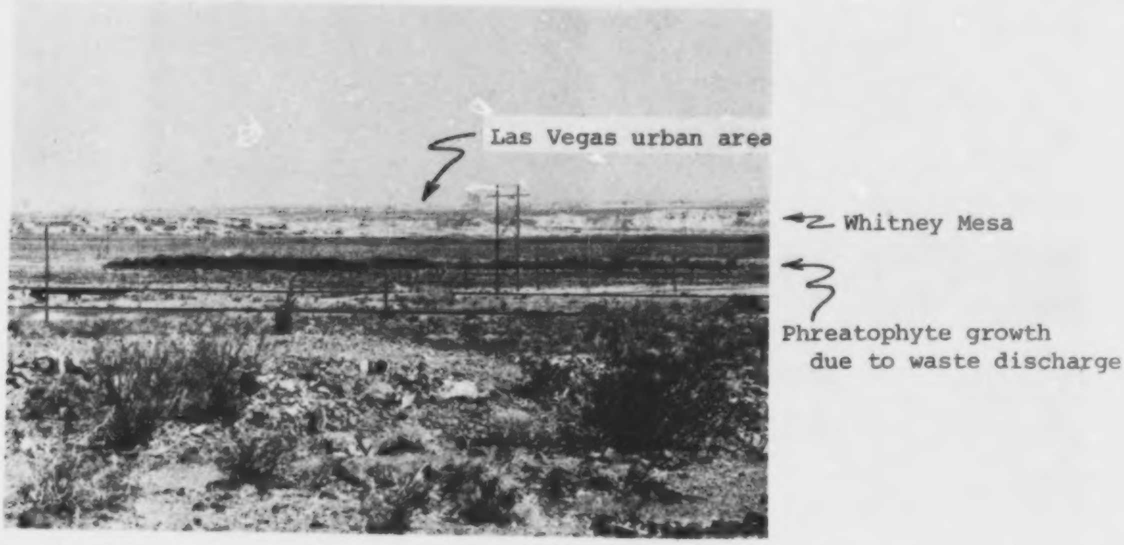

Las Vegas urban area
Whitney Mesa
Phreatophyte growth due to waste discharge

Figure 4. Photograph of Whitney Mesa as viewed looking northwest from Las Vegas Wash.

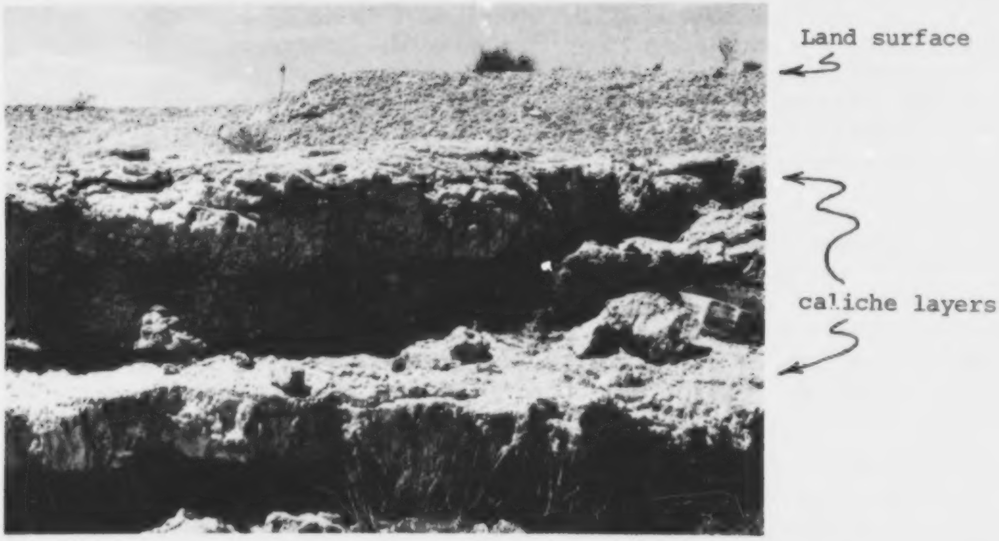
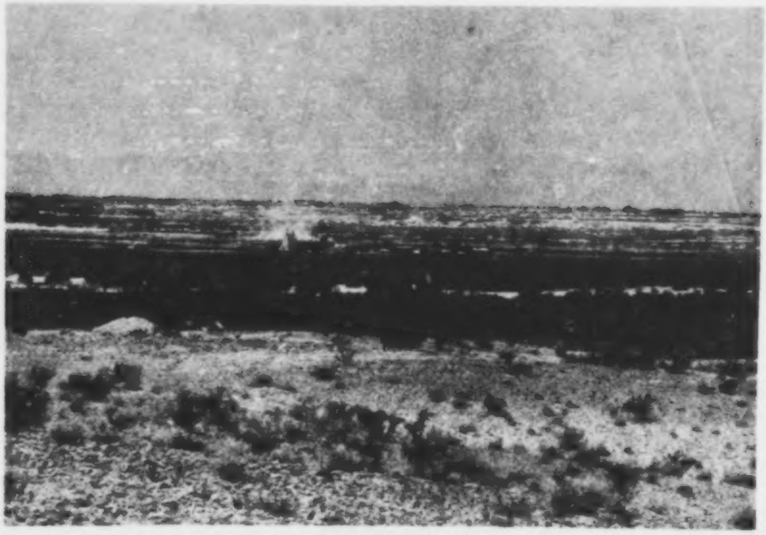

Land surface
caliche layers

Figure 5. Photograph of caliche layers in the vicinity of Tropicana and Polaris Avenues.


Fault scarp

Waterlogged areas
near Las Vegas Wash

Figure 6. Photograph of the upper Las Vegas Wash area showing a principal fault scarp in the background and waterlogged areas.

PRINCIPAL AQUIFER ZONES

Four principal aquifers in Las Vegas Valley were identified by Maxey and Jameson (1948). In the northwestern quarter of the Valley, they recognized a near surface aquifer to depths of 200 feet. Below this, to depths of 450 feet, the shallow aquifer is present and consists of sand and gravel interbedded with silt and clay. At the base of the shallow aquifer in parts of the Valley they reported that a fairly persistent layer of blue clay overlies the highly productive middle aquifer, the principal source of ground water pumped in the Valley. A deep aquifer, recognized at depths below 700 feet in the western half of the Valley, has only been developed in recent years. Subsurface conditions vary laterally so the aforementioned aquifer relations do not generally persist east of the principal scarp.

Because of decreasing quantities of sand and gravel from west to east, aquifers in the eastern two-thirds of the Valley yield progressively less water and wells rarely exceed a depth of 500 feet. There is a loss of productivity accompanied with natural deterioration in quality toward the east and southeast. As a result, considerably less ground-water development occurs in these areas. Zones of highest transmissivity occur between depths of 200 to 900 feet in the area between Charleston Boulevard and Tonopah Highway and west of the East 1/2, Section 32, Township 20 South, Range 61 East (20/61-32, E 1/2)[2]. The principal pumping centers are shown in Figure 3. In an area of one-half square mile, the main well field (Charleston well field) of the Las Vegas Valley Water District produced approximately 60 percent of all the ground water extracted in the Valley until 1973. Since the late 1960's, ground water production by the Las Vegas Valley Water District and the City of North Las Vegas has rapidly shifted to the north and west and has featured deeper wells of higher yield.

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[2] The location system used in this report is described in Appendix 3.

Less transmissive tongues of cemented gravel separated by clay and silt aquitards are present in the remainder of the urbanized area lying west of a north-south line passing approximately through the southern reach of the Las Vegas Strip. Relatively thin gravel lenses extend east of this line. Throughtout the developed portion of the Valley, shallow aquifers in the upper few hundred feet consist of sand and gravel lenses, or thin layers of porous caliche conglomerate or caliche sandwiched between thick silt and clay sediments. Highly permeable zones, probably representing former wash channels extend generally east-west through finer-grained sediments and are most common in township 21/61. Similar linear trending zones of high permeability are likely in those portions of Paradise Valley located in the Duck Creek subbasin.

In general, unconfined ground water is present at depths ranging from less than 10 to more than 200 feet below the land surface in the urbanized portion of the Valley. Where thick caliche units are present near the land surface, near surface ground water can be locally confined under several feet of head.

RECHARGE-DISCHARGE RELATIONS

Previous studies by Maxey and Jameson (1948) and Malmberg (1961) concluded that recharge to the Las Vegas Valley ground-water basin is a result of precipitation in surrounding mountainous catchment areas. Rainfall and snowmelt in the Spring Mountains and, to a lesser extent in the Las Vegas and Sheep ranges, probably infiltrate directly into the bedrock or flanking alluvial aprons. Minor recharge probably occurs in the McCullough Range and possibly from the Frenchman-Sunrise Mountain block east of the Valley. Studies by Winograd and Friedman (1972) and more recently by Winograd and Thordarson (1975) indicate that the recharge area may extend beyond the topographic basin but to what extent in terms of area and volume of recharge is unknown. Figure 3 illustrates the principal directions of lateral flow in the near surface zone.

Estimates of recharge and discharge prepared by Maxey and Jameson (1948) and Malmberg (1965) indicate ground-water flux of 21,000 to 35,000 acre feet per year under natural conditions. With heavy overdraft of the artesian aquifers beginning in the mid-1940's, followed by importation of water in the 1950's, the natural water balance has been severely disrupted in terms of volume, distribution, and quality because discharge formerly equaled recharge and no water (except flood flows) exited the Valley except flow from uncontrolled flowing wells in the 1920's and 1930's.

The principal sources of recharge to the near surface system include irrigation return flows, septic tank and sewage treatment plant effluents, industrial effluent ditches and disposal ponds, and upward flow from deeper, artesian aquifers. Discharge from the system occurs as direct evaporation, evapotranspiration from phreatophytes, and discharge to surface water courses. Ground-water discharge causing surface flow is significant only in the Las Vegas Wash area. In the remainder of the Valley recharge to the near surface system results in positive change in storage, downward movement to the deeper, heavily pumped aquifers, and development of small springs and seeps.

Under natural, predevelopment conditions, the only ground-water outflow from the Valley was Las Vegas Wash underflow which is estimated at about 250 acre feet per year or less. At present an additional 12,300 acre feet per year of underflow surfaces in the lower reaches of Las Vegas Wash (Kaufmann, 1971; Westphal and Nork, 1972). In the developed portions of the Valley, major springs and artesian wells have ceased to flow as a result of heavy pumping. Extensive mesquite groves and stands of saltbush that formerly discharged 25,000 acre feet per year have been removed and replaced with suburban sprawl and extensive lawns. Exclusive of Henderson and the BMI effluents, recharge to the shallow aquifer in 1973 amounted to 38,500 acre feet per year (Patt, 1977) and represented water which was 1) going into storage, 2) leaking downward to recharge the deeper aquifers, or 3) flowing laterally toward Las Vegas Wash.

HYDROGEOLOGY OF THE NEAR SURFACE ZONE

The near surface zone as used herein is defined as that portion of the total ground-water system occurring within 300 feet of land surface. It, therefore, includes the near surface zone and part of the shallow zone as defined by Maxey and Jameson (1948). Initial attempts to more rigidly characterize shallow ground water in terms of boundary conditions, permeability distribution, or water quality revealed a high degree of natural variability and a lack of precise data. Therefore, a "slice" approach was used, analogous to that of Domenico et al. (1964).

Based on their observations in the period from 1940 to 1956, Maxey and Jameson (1948) and Malmberg (1965) described the near surface zone as follows:

1. Depths to water range from a few feet to a few tens of feet below land surface.

2. Recharge is by upward movement from underlying aquifers and by downward percolation of surface water.

3. Natural discharge is solely from evapotranspiration.

4. Transmissivities are low and the amount of water moving laterally through the sediments is small.

In the present study several thousand well logs and soils/engineering reports were examined for lithologic and water level data to determine 1) if there is a geologic basis for differentiating between the near surface and deeper flow systems and 2) the areal extent of the near surface system. Except in a few cases where well locations were verified in the field, water level elevations and elevations of lithologic horizons were obtained through use of 7½ minute or 15 minute topographic maps in conjunction with reported well locations. As expected, drillers' descriptions of lithology were extremely variable with respect to units encountered in a given area.

A network of northward trending, roughly parallel fault scarps occupy the central portion of the Valley (see Figure 3) and affect ground-water movement. The most prominent scarp extends northwest from 22/62-4 in the vicinity of Whitney Mesa to downtown Las Vegas then north through North Las Vegas and the Craig Country Club (20/61-3). Lower Las Vegas Valley is considered to be the area east of Whitney Mesa and southeast of the Las Vegas Wastewater Treatment Plant. East Las Vegas, Pittman, and Henderson are the principal communities in lower Las Vegas Valley.

The near surface zone consists primarily of clay and silt with interstratified deposits of sand, gravel, and caliche. Near the main north-south scarp, fine-grained Muddy Creek or Pleistocene sediments are widespread, particularly east of the scarp. Figure 7 shows the fine-grained sediments comprising the scarp in the vicinity of Cashman Field in North Las Vegas. Ground water flowing across the scarp face exists the excavation indicated by the arrow. The horizontal line indicates the approximate upper boundary of saturation. Farther west in the vicinity of Valley View Drive and the Las Vegas Expressway, areally extensive and highly indurated caliche is at the surface or near surface. As shown in Figure 8, the fine-grained sediments between caliche layers are saturated and require emplacement of under-drains to allow construction in this area. Subsurface conditions are nearly identical in the vicinity of Decatur Boulevard approximately three-quarters of a mile west.

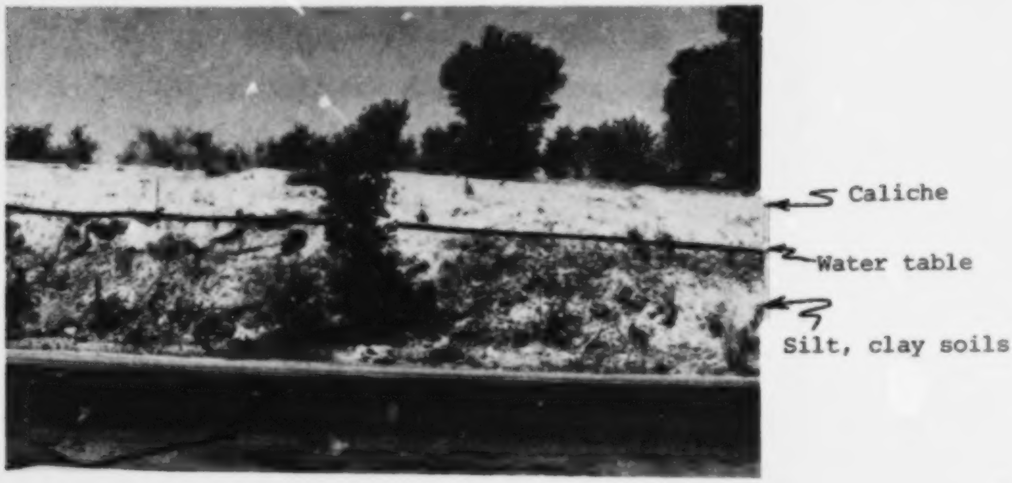


Figure 7. Closeup view of the upper part of the fault scarp shown in Figure 6. Photograph taken approximately one-quarter mile south of Cashman Field in the vicinity of 9th Street and Harris Avenue.

In the vicinity of the recently constructed West Charleston reservoir near Buffalo Drive, there is a thick section of unsaturated, moderately well cemented sands and gravels (Figure 9). The caliche is sufficiently indurated that fracturing occurs across rather than around the larger clasts (Figure 10).

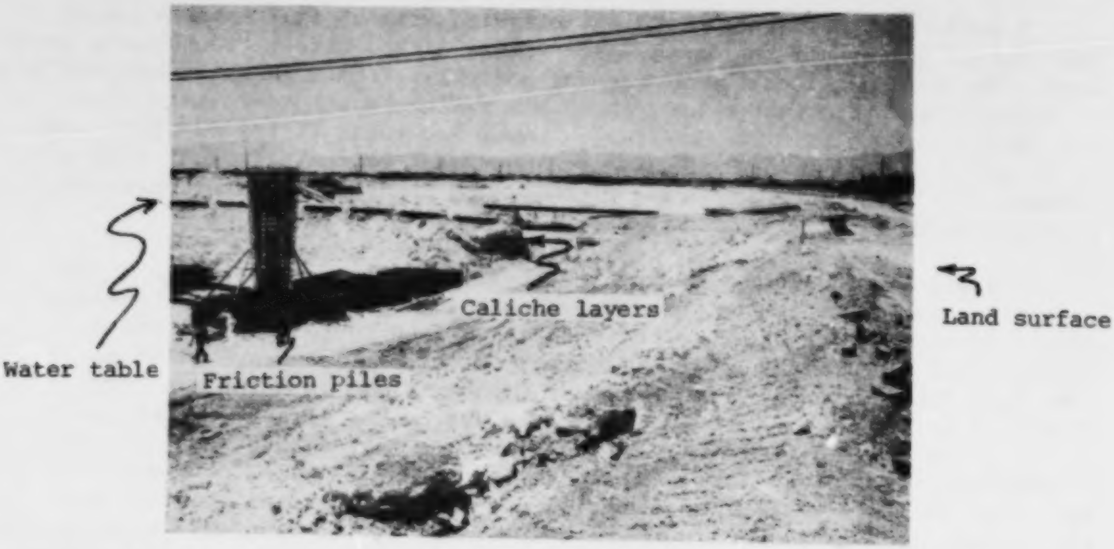

Water table
Friction piles
Caliche layers
Land surface

Figure 8. Photograph of an excavation for the Las Vegas Expressway taken at Valley View Boulevard.

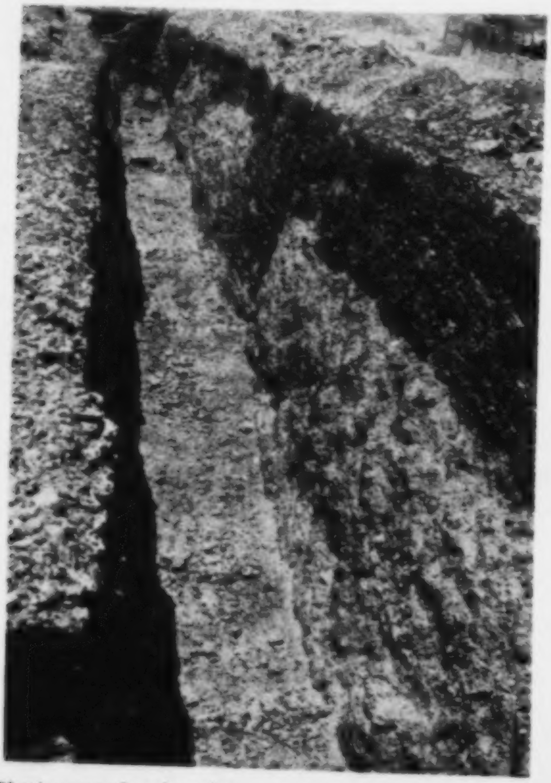


Figure 9. Photograph showing cemented gravels in surficial alluvial fan deposits in the vicinity of Charleston Boulevard and Buffalo Drive.

Nevertheless, close-up views reveal the rounded particles and give some indication of high residual porosity and permeability, despite cementation (Figure 11). Significant amounts of aquitard materials in upper zones are absent from driller reports for the areas west of Jones Boulevard. Displacement appears to decrease with each minor scarp west of the main north-south scarp. Subsurface data from water well logs show an east to west facies change from fine-grained sediments to coarser materials characteristic of alluvial fans.

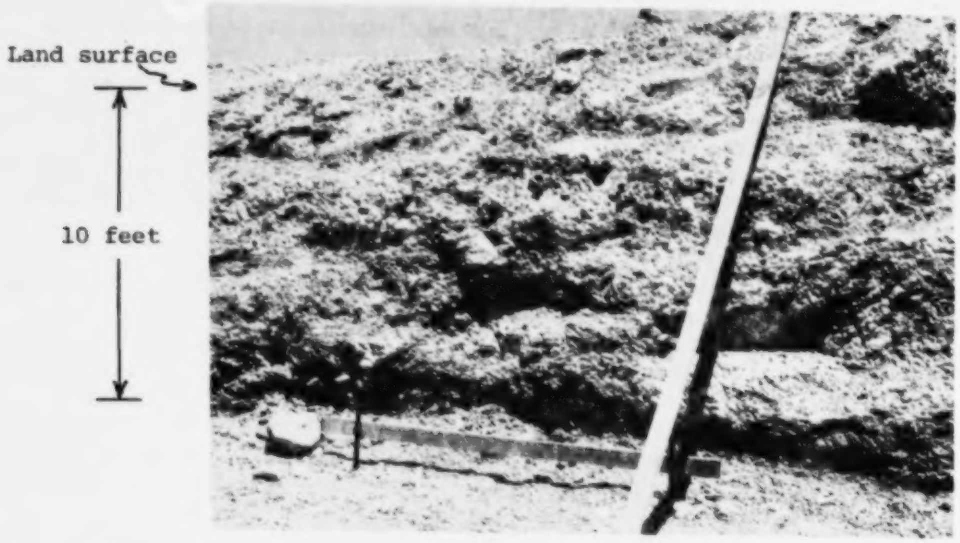


Figure 10. Photograph showing the degree of induration in the West Charleston Boulevard and Buffalo Drive area. Note the occurrence of fracturing across clasts.

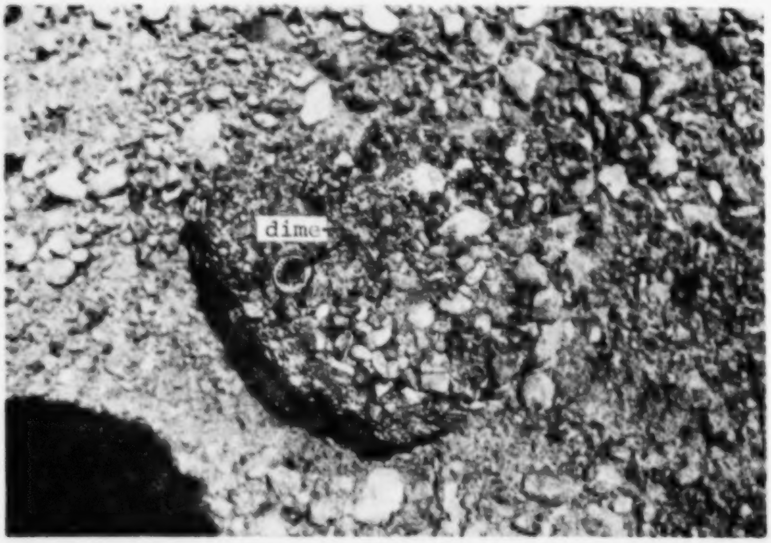


Figure 11. Closeup photograph of cemented gravel in the Charleston Boulevard and Buffalo Drive area (note dime for scale).

To clarify understanding of the facies changes generally described above, east-west stratigraphic cross-sections (Figure 12, 13, 14) were prepared from logs of wells and soil borings. Although the cross-sections portray the general changes in sediment type and distribution, there is insufficient lithologic description in the available logs to describe separate aquifer zones in detail. Attempts to use Markovian analysis of vertical variability as an estimate of lateral variability were also unproductive.

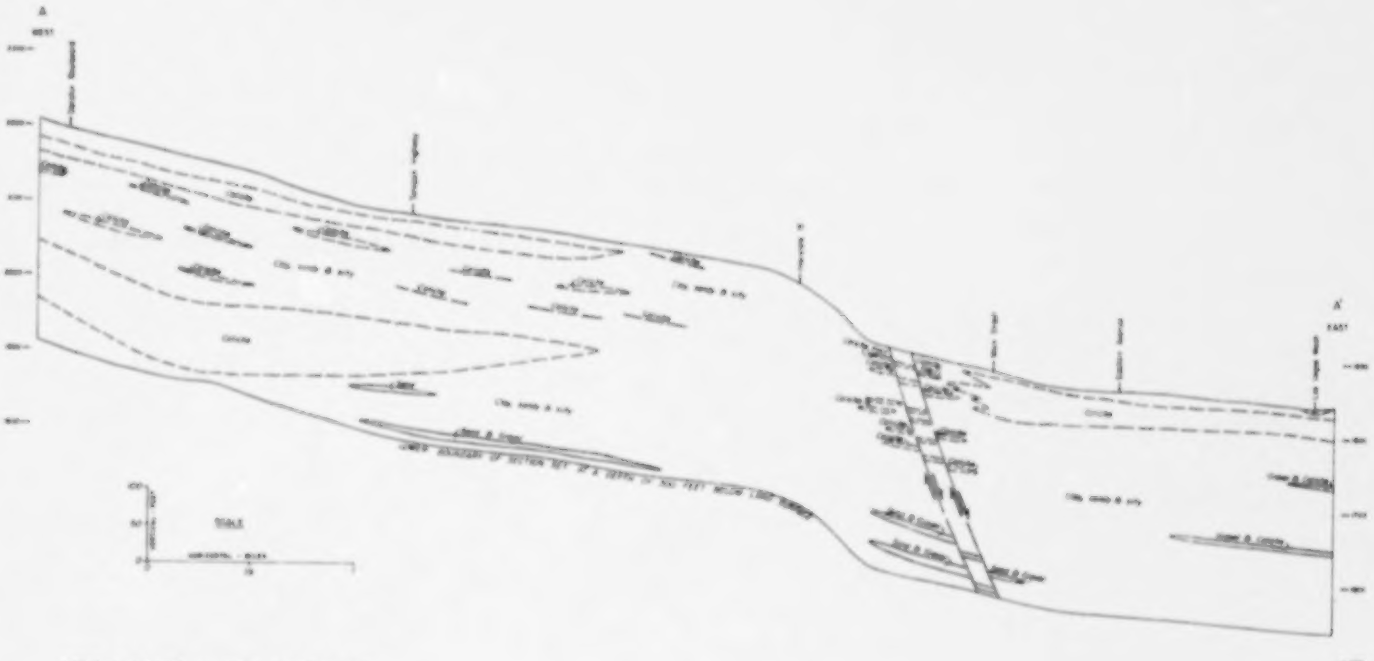
It is apparent from the cross-sections that the upper 300 feet of sediments in the western part of the Valley contain considerably more coarse-grained sediments in the form of sand, gravel, cemented gravel and caliche conglomerate. The thin but impermeable and extensive caliche units and interbedded silt and clay layers create marked permeability boundary conditions. In the eastern part of the Valley, transmissivity decreases due to the dominance of caliche, silt, and clay. Although only one or two fault planes are shown in the cross-sections, other faults with small throws are believed present, particularly west of the scarp shown.

In addition to stratigraphic or lithologic definition of the near surface zone, water level information was also utilized. Figure 15 depicts the hydraulic potentials in the near surface zone between 1970 and 1973. In the western part of the Valley water level data were obtained from soil boring records and driller reports for wells completed in the near surface zone. The exception was in the general area west of Jones Boulevard where the bottom of the near surface zone can not be distinguished. In that area, water levels in wells 300 feet deep or less were used. Because it was not possible to define the near surface zone in the northeast part of the Valley on the basis of lithologic data, a well depth criterion of 300 feet or less was also used.

Water level data were examined to determine the influence of geologic materials on hydraulic potentials in the near surface zone in an eight square mile area centered on Charleston Boulevard west of Rancho Road. The area was selected for study because of its proximity to the Las Vegas Valley Water District's Charleston well field (20/61-32), the known presence of extensive layers of caliche, and availability of well data. To minimize the effect of temporal variation in driller reported water levels, wells were divided into groups according to date drilled. Water level comparisons are shown in Table 1.

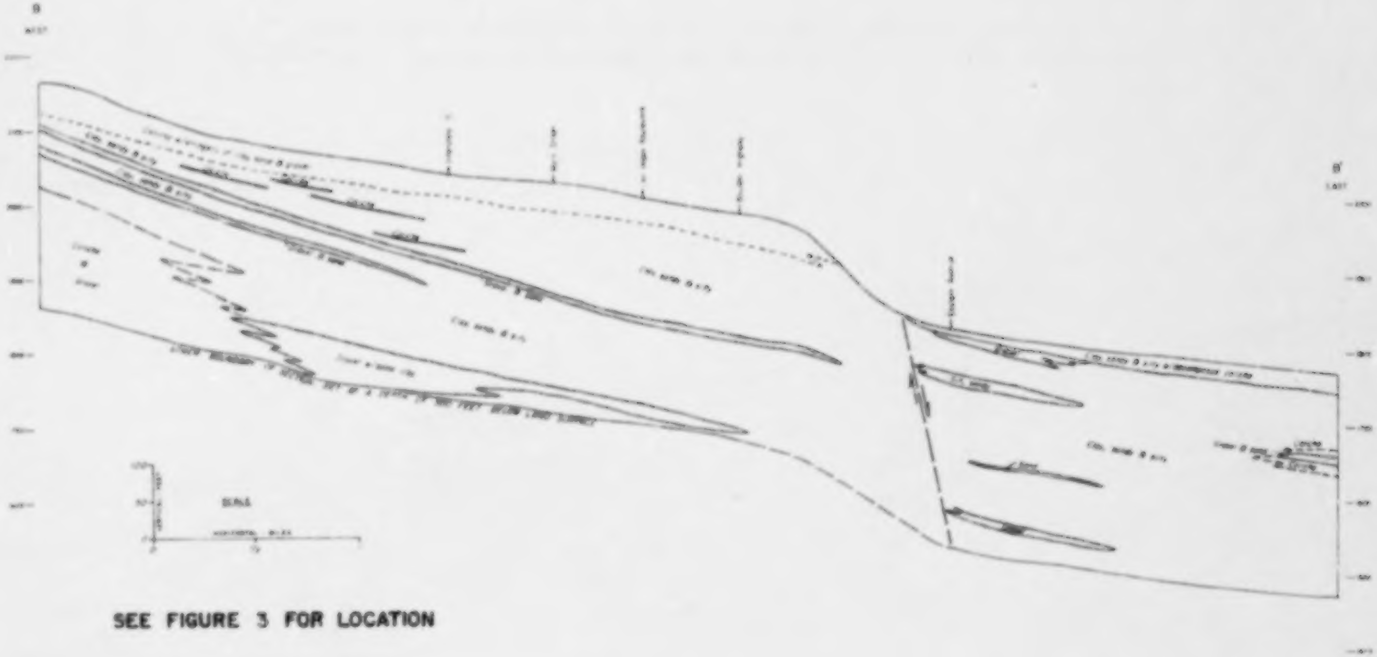
It is evident that heads were above the bottom of the near surface zone where it was distinguishable as such. This was true even in the vicinity of the well field where potentials in the deep artesian aquifer were 160 feet below land surface. The 1971 and 1972 data indicated a gradient reversal, i.e. downward, probably as a result of pumping from the middle and deep aquifers. The downward gradient provides opportunity for the migration of water from the near surface aquitard into underlying middle zone aquifers. Furthermore, the head data in Table 1 suggest this condition has existed since the mid-1950's. Thus, downward transfer of poor quality water may be occurring in this part of the Valley.

From the efforts to stratigraphically and hydraulically define the near surface zone and from careful review of previous studies, the Valley was


A
WEST
A'
EAST
SCALE

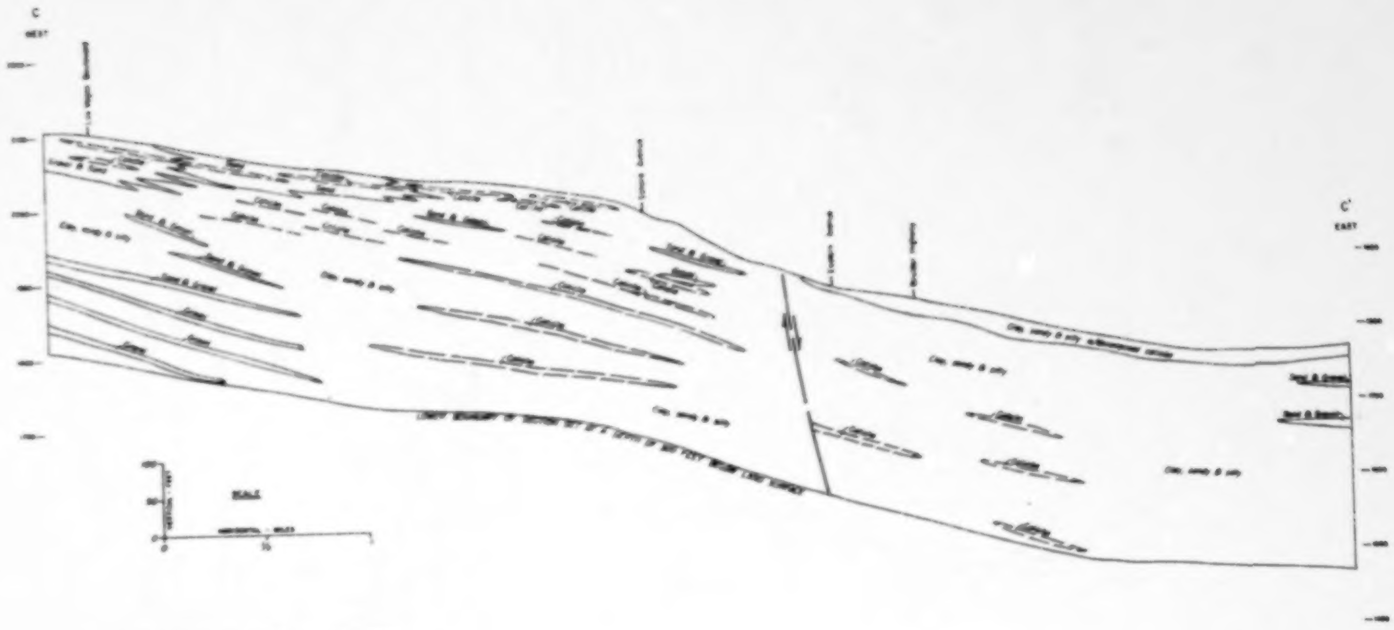
SEE FIGURE 3 FOR LOCATION

Figure 12. Idealized geologic cross section A-A' from the West Charleston Boulevard area and Nellis Air Force Base.


B
WEST
B'
EAST
SCALE

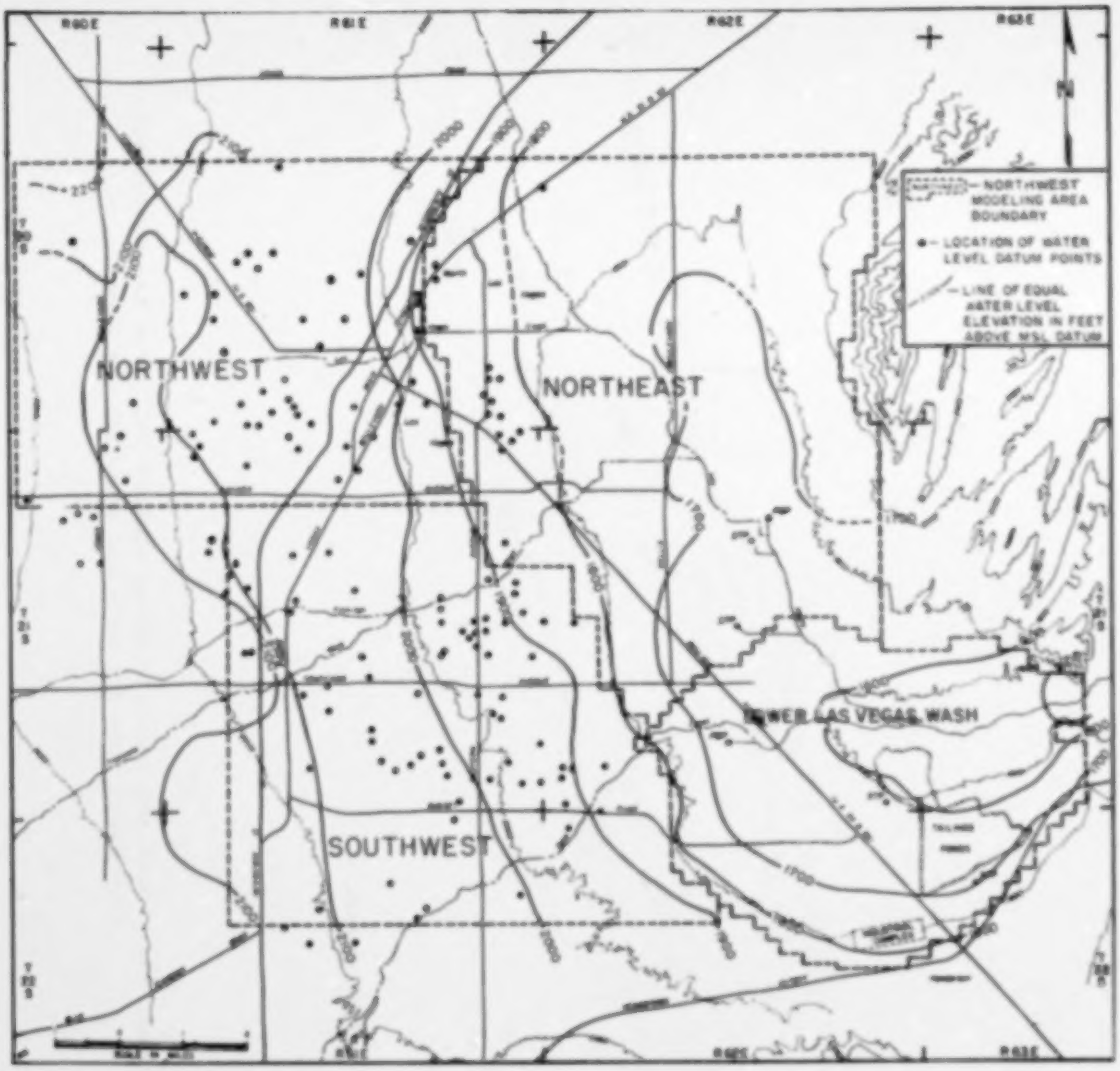
SEE FIGURE 3 FOR LOCATION

Figure 13. Idealized geologic cross section B-B' from the West Charleston Boulevard area and downtown Las Vegas.


C
WEST
C'
EAST
SCALE

SEE FIGURE 3 FOR LOCATION

Figure 14. Idealized geologic cross section C-C' from Las Vegas Boulevard South (the "Strip") and downtown Las Vegas.



R60E
R61E
R62E
R63E
N
NORTHWEST MODELING AREA BOUNDARY
● – LOCATION OF WATER LEVEL DATUM POINTS
LINE OF EQUAL WATER LEVEL ELEVATION IN FEET ABOVE MSL DATUM
2100
2000
1900
1800
1700
NORTHWEST
NORTHEAST
SOUTHWEST
LOWER LAS VEGAS WASH

Figure 15. Water table map of the "near surface" zone, with an outline of the ground-water flow model areas.

TABLE 1. COMPARISON OF REPORTED WATER LEVELS IN WELLS OF DIFFERENT DEPTHS IN THE WEST CHARLESTON BOULEVARD AREA

Location T/R	Location Sec	Location Quarter	Year Drilled	Well depth (feet)	Water level elevation*	Comments
20/61	32	231	1951	70	2100	Very shallow wells indicating water table position only
		422	1951	140	2075	
		321	1952	160	2100	
20/60	35	443	1955	150	2158	No boundary indicated. Wells located between Decatur Blvd. and Wilshire Street
		444	1955	166	2160	
		443	1955	236	2165	
	36	41	1959	81	2150	No boundary indicated.
		432	1960	225	2149	
		444	1960	250	2135	
21/60	01	33	1959	200	2113	Boundary estimated to be between 200 to 252 feet below surface
		434	1960	250	2130	
		31	1961	252	2135	
		34	1960	300	2130	
		42	1959	300	2125	
		42	1962	300	2120	
	03	41	1954	110	2180	Boundary estimated to be 230 to 246 feet below surface
		41	1955	110	2157	
		42	1955	162	2170	
		42	1954	170	2160	
		41	1955	175	2162	
		42	1955	220	2150	
		33	1953	230	2186	
		22	1957	246	2135	
21/60	02	22	1955	240	2190	Boundary estimated to be 243 to 265 feet below surface
		22	1955	243	2190	
		23	1954	260	2165	
		23	1954	265	2165	
		22	1955	270	2140	
		22	1955	300	2155	
21/61	06	222	1971-1972	50	2057	Boundary between shallow and deeper aquifers indicated
20/61	33	323	"	170	2038	
		233	"	395	2007	
20/60	36	334	"	149	2151	Boundary between near surface and shallow aquifers indicated
	36	244	"	610	2002	
21/60	01	342	"	170	2132	
21/60	12	124	"	154	2129	Boundary between shallow and near surface aquifers indicated
		232	"	320	2031	
21/60	11	434	"	273	2066	No boundary apparent from water levels. Located between Jones Blvd. and mad line of 21/61-11
		123	"	700+	2026	

* Final static water level reported by driller at time of well completion. Static level in feet above mean sea level.

divided into four separate areas, each of which have broadly similar hydraulic and geologic conditions (see Figure 15). The lower reach of Las Vegas Wash and environs constituted one such area whereas the remainder were in the urbanized portion of the Valley.

GROUND-WATER QUALITY

INTRODUCTION

Previous documentation of ground-water quality in Las Vegas Valley, regardless of depth, is notoriously deficient. The resource, in terms of quality, has largely either been taken for granted or ignored. In-valley effluent disposal practices are cases in point. Very limited discussions of water quality are presented in Mendenhall (1909), Carpenter (1915), Hardman and Miller (1934), Maxey and Jameson (1948), and Malmberg (1965). An unpublished water quality map produced by Domenico and Maxey (1964) depicted zones or regions of TDS as indicated by specific conductance. The water sampling program of the District Health Department resulted in several thousand water analyses for the period 1968 to present but there was no previous attempt to reduce and interpret the data. The Las Vegas Valley Water District and the City of North Las Vegas have additionally monitored their wells in the western part of the Valley; however, few data prior to 1969 are available. The present study, then, represents the first attempt at description of ground-water quality in Las Vegas Valley. A subsequent effort by Dinger (in preparation) relates shallow ground-water quality to geologic conditions.

Changes in ground-water quality with time in Las Vegas Valley might be expected for a number of reasons, some of which are:

1. Extensive overdraft of deeper artesian aquifers resulting in downward leakage of poorer quality water from overlying aquitards and induced lateral inflow of poorer quality water in the central portion of the basin.

2. Terrestrial disposal of sanitary and industrial wastes.

3. Septic tank waste disposal systems.

4. Importation of increasing amounts of more saline Lake Mead water and subsequent distribution within the Valley.

5. Irrigation of lawns, golf courses, parks, and commercial crops with potable and wastewater, resulting in leaching of highly alkaline soils and salt concentration due to consumptive use.

6. Discharge from evaporative coolers.

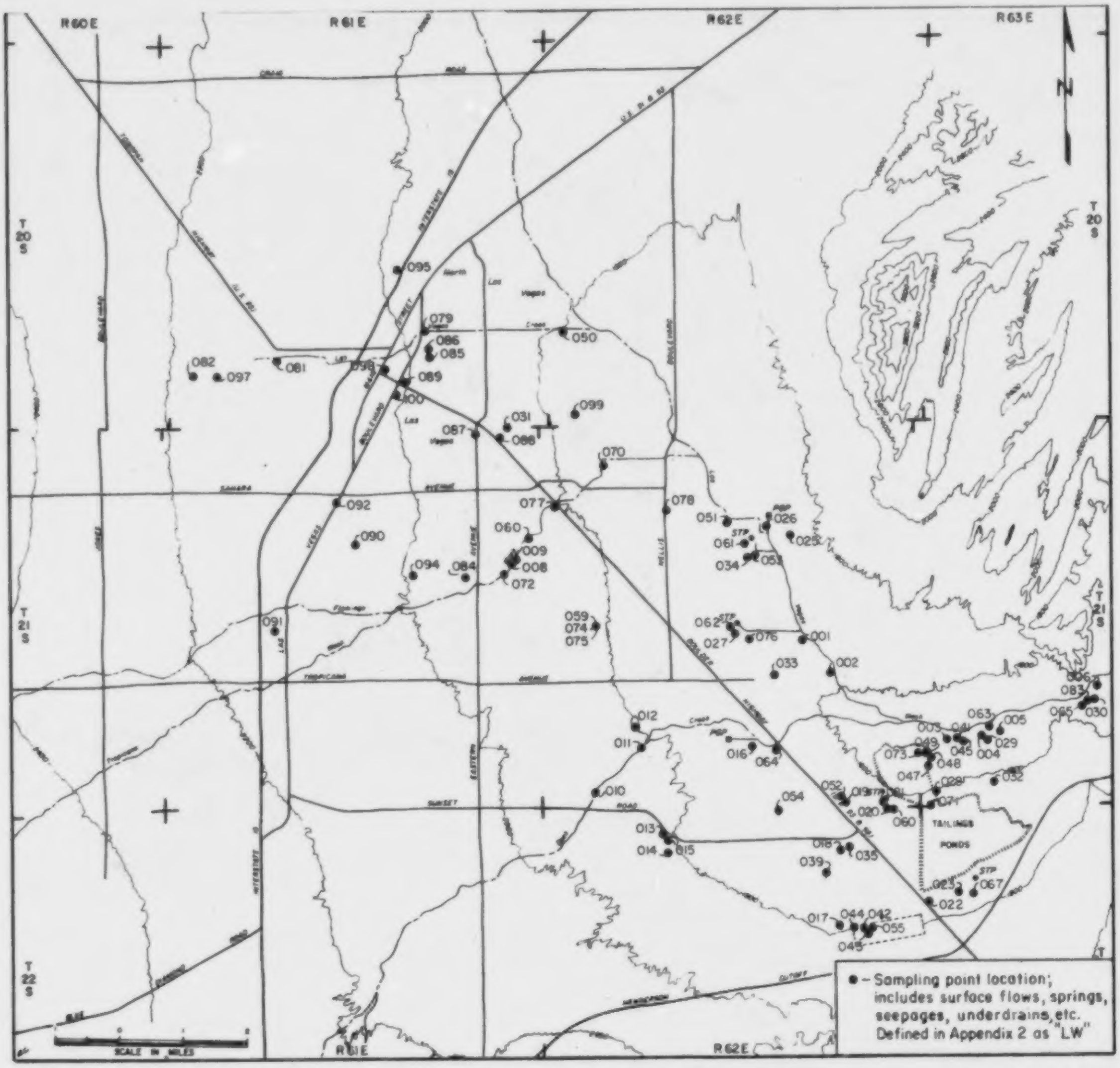
METHOD OF STUDY

For the urban and suburban areas of the Valley, ground-water quality variations through space and time were analyzed using trend surfaces and nonparametric statistical tests, respectively. With background or ambient conditions established, attention was then directed to specific land and water use practices instrumental in affecting ground-water quality. In this regard, tritium and nitrate data were used to document return flows associated with urbanization and industrialization. Three chemical data bases were utilized: 1) historical analyses from 1909-1964 (supplemental by resampling of the same wells or substitutes, where possible), 2) chemical data on file at the District Health Department and representative of valley-wide sampling of domestic and municipal wells from 1968-1972, and 3) approximately 2,000 water analyses of shallow ground water, effluents and potable water sampled as part of the study in the period 1970-1973.

Extensive water sampling, flow measurements, and installation of 36 new wells in the first year of the study resulted in the generation of an essentially new data base for the lower reaches of Las Vegas Wash and adjacent areas in Henderson, Whitney, Pittman, and East Las Vegas. In the remainder of the Valley, principal reliance was placed on available water analyses and well records, supplemented with a limited number of shallow wells and water analyses therefrom. Well characteristics are stated in Appendices 1 and 5.

Surface and ground-water samples from stations located throughout the Valley as shown Figures 16 and 17 and described in Appendix 2, were collected from February 1970 through September 1973 to characterize quality with respect to gross chemistry, trace elements, nutrients, and tritium. This effort focused on sampling areas and depths not included in the District Health Department sampling program and(or) to supply new data for locations previously sampled by earlier researchers. In this way temporal comparisons could be made. With respect to the Las Vegas Wash area, samples for gross chemical analysis were predominantly collected on a monthly basis for ground-water and surface water points. For all samples except those collected for tritium analysis, the following determinations were made: pH (laboratory), specific conductance (field and laboratory), temperature, bicarbonate, carbonate, chloride, sulfate, phosphate, fluoride, nitrate, ammonia, and four principal cations. Analytical results for water samples collected in the course of the study are shown in Appendices 3 and 6. With the exception of the section describing historical changes in water quality, the interpretations herein are based on samples collected from February 1970 through September 1973. Subsequent data shown in Appendix 3 are for information only.

Spatial variations in ground-water quality, particularly for depths below 50 feet, were determined largely from District Health Department data. Analyses from January 1, 1968 through 1972 were selected for depth intervals 0 to 50 feet, 51 to 100 feet, and 101 to 300 feet providing the anion:cation ratio was in the range 0.9 to 1.1. From card decks of acceptable analyses plots of sampling point locations were prepared to determine density of data points in the study area for the three depth intervals selected. In areas of high density, analyses for depth intervals 51 to 100 feet and 101 to 300 feet were averaged to one value per quarter section to avoid undue weighting of the polynomial equations describing the trend surfaces. For these same depth intervals, data decks containing only actual, versus averaged, data were prepared to plot the locations where various water quality parameters exceeded a threshold value, usually the U. S. Public Health Service (1962) standard for drinking water.


R60E
R61E
R62E
R63E
T 20 S
T 21 S
T 22 S
N
North Las Vegas
Las Vegas
SAHARA AVENUE
TROPICANA AVENUE
SUNSET ROAD
CRAIG ROAD
BOULDER HIGHWAY
INTERSTATE 15
U.S. 93 & 95
EASTERN AVENUE
TAILINGS PONDS
STP
SCALE IN MILES
095
079
086
085
050
082
097
081
098
089
100
031
099
087
088
070
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077
078
051
026
025
061
034
053
060
009
008
072
090
094
084
091
059
074
075
062
027
076
001
033
002
006
083
030
065
063
005
003
041
029
045
004
073
049
048
047
028
032
012
011
016
064
010
054
052
019
020
080
071
013
014
015
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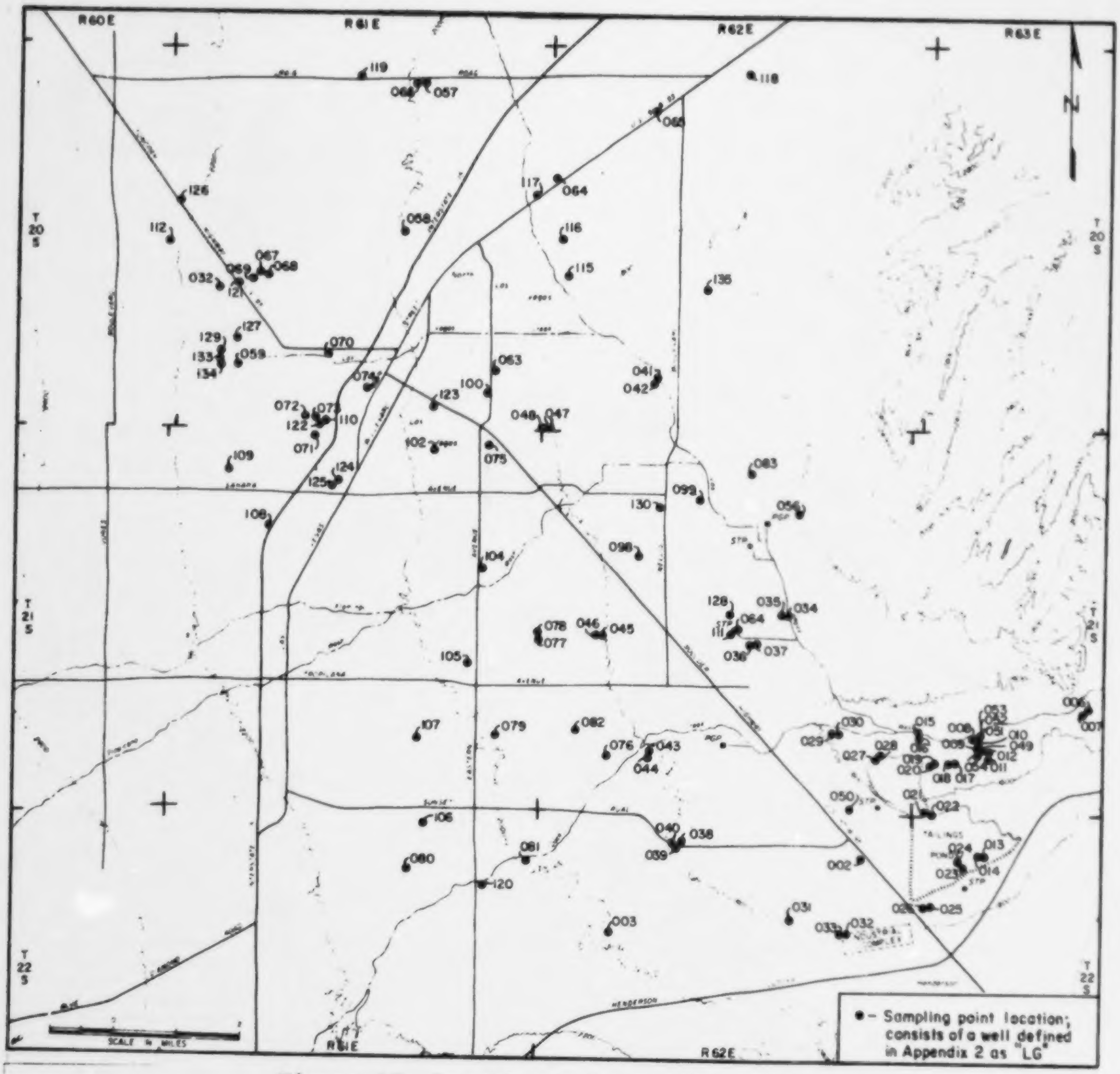
039
023
067
022
017
044
042
055
043
● - Sampling point location; includes surface flows, springs, seepages, underdrains, etc. Defined in Appendix 2 as "LW"

Figure 16. Locations of surface water, spring, and seep sampling stations.


R60E
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R62E
R63E
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T 20 S
T 21 S
T 22 S
119
066
057
118
065
126
112
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064
058
116
115
135
067
069
068
032
121
127
129
133
059
134
070
063
041
042
074
100
123
072
073
122
110
071
048
047
102
075
109
124
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083
099
130
056
108
098
104
128
035
034
064
111
036
037
078
077
046
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105
107
079
082
076
043
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015
016
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019
020
018
017
008
009
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052
051
010
049
012
011
006
007
050
021
022
106
040
038
039
080
081
120
024
013
002
023
014
026
025
031
033
032
003
R61E
R62E
SCALE IN MILES
● – Sampling point location; consists of a well defined in Appendix 2 as "LG"

Figure 17. Locations of sampling wells.

The data base was also used to produce hydrochemical facies maps for the depth interval from 101 to 300 feet. The plotting routine was used in combination with a program which categorized each water analysis into 1 of 16 facies or classes of water quality resulting from different sediment composition and source areas, variations in residence time within the flow system, and effects of ion exchange with fine-grained sediments. Domains of dominant classes or facies were mapped to show trends throughout the area where data were available.

The data decks were also used to generate trend surfaces depicting the trend for various water quality parameters. Data availability varied with the depth interval considered. In the case of the depth interval from 0 to 50 feet, only TDS, chloride, and nitrate were considered as the water was clearly not potable and these parameters were considered most indicative of return flows from developed and agricultural areas. In addition to the trend surfaces for each parameter, CALCOMP plots of actual values by location were made to enable a visual scan of the raw data and selection of the contour interval and reference contour for the trend.

The trend surface technique involves fitting polynomial surfaces to map data by means of a general linear model incorporating a least-squares fit of a planar or curvilinear surface to the observed data. More complex surfaces involved higher order polynomials and more terms in the equation collectively relating each datum (Z) to its location (X, Y) in the area of consideration. In theory, there is no upper limit to the exponents but the most useful trends seldom exceed the fifth or sixth degree. The coefficient of correlation statistic expresses the variation accounted for, which typically is in the range of 60 to 90 percent and progressively greater for the higher order polynomials.

In the past, trend surface analysis has primarily been applied to stratigraphic, structural and sedimentation problems involving such topics as analysis of lithofacies variations, source areas for heavy mineral assemblages, and evaluation of economic deposits of oil, gas, and ore. Davis et al. (1969) applied trend surface analysis to a problem involving ground-water use, replenishment and aquifer characteristics in Indiana. A bibliography of the applications is found in Krumbein and Greybill (1965) and in Lustig (1969). For the present study, trend surfaces were relied upon to portray chemical quality of ground water for several reasons. From a research standpoint, the method had not been adequately tested and applied to ground-water quality problems. Another consideration was the need to reduce and generalize a great mass of chemical data, some of which were of questionable veracity. Retrieval of raw data for manual plotting and contouring would have been extremely time consuming and inefficient. Finally, broad overall trends are analytically more useful in describing variations in Las Vegas Valley.

DEEP GROUND-WATER QUALITY (depth interval 101 to 300 feet)

Figure 18 shows the location of water analyses taken to describe changes in the depth interval from 101 to 300 feet. Fewer analyses available in approximately the central portion of the study area reflect gradual destruction of wells in the older urban developments which are now relying on municipal water systems. Light density in the north-central portion is largely a result of nondevelopment.

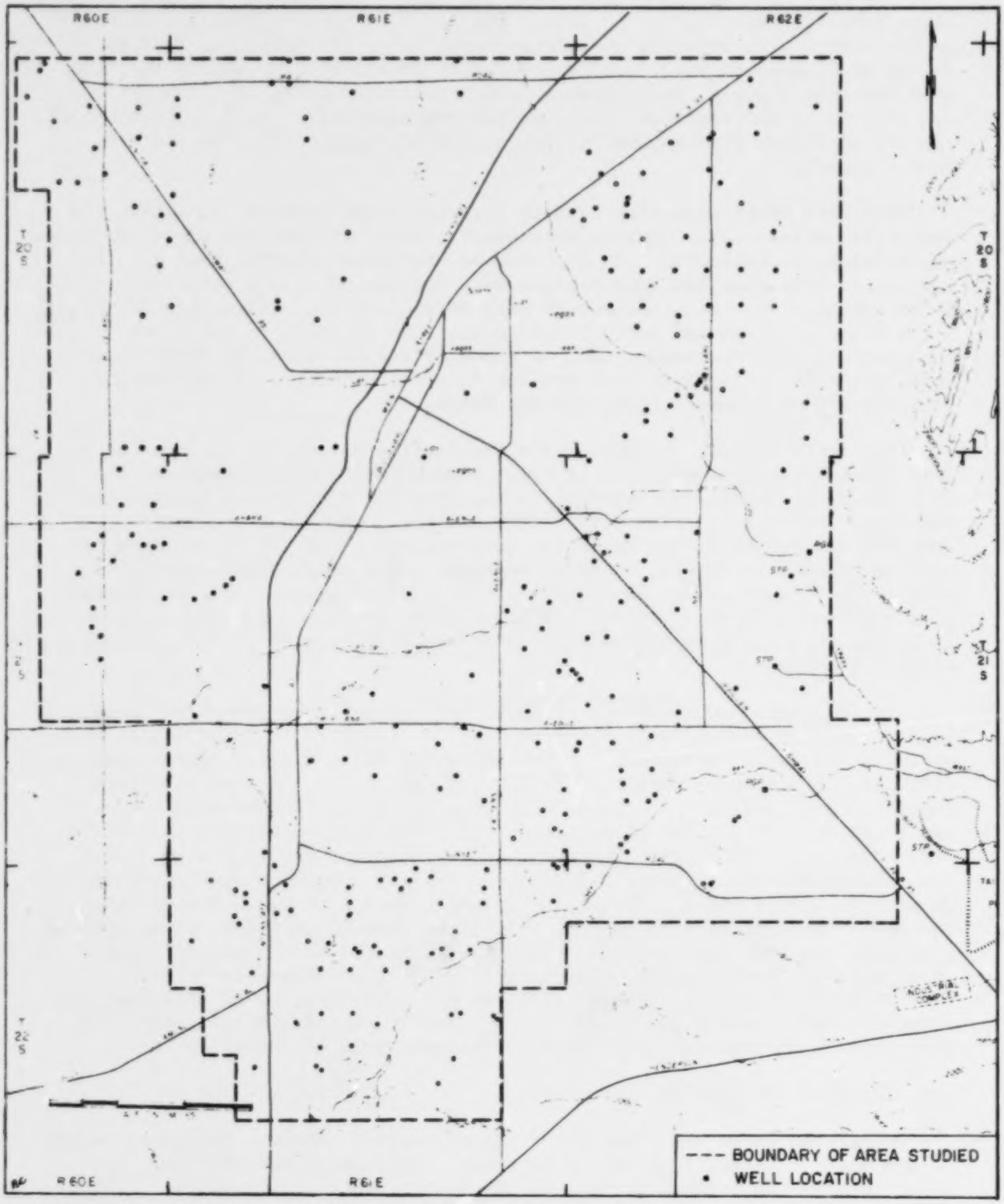

R60E
R61E
R62E
N
T
20
S
T
20
S
21
S
T
21
S
T
22
S
STP
STP
STP
INDUSTRIAL COMPLEX
R60E
R61E
--- BOUNDARY OF AREA STUDIED
• WELL LOCATION

Figure 18. Locations of domestic wells and selected test wells used to characterize ground-water quality at depths of 101 to 300 feet in the period 1968-1972.

First order or regional trends in TDS for the three depth intervals considered are shown in Figure 19. At depths of 101 to 300 feet, the progressive increase in mineralization of ground water along the valley-wide flow path is primarily a function of natural hydrogeologic controls. This is shown in more detail in Figures 20 and 21, which are hand-contoured and sixth degree trends of TDS at depths of 200 to 300 feet and 101 to 300 feet, respectively. Although both maps generally agree, the hand-contoured version is less useful in depicting broad, valley-wide conditions, despite the fact that data are averaged to one value per section. The sixth order trend (Figure 21) reveals minimum concentrations of approximately 300 mg/ℓ in the northwestern sector along the principal ground-water flow path into the Valley. From this point flow is eastward across the northern half of 20/61, and southeastward toward Las Vegas Wash. Mineralized ground water present along the west central and southern portions of the study area reflects the presence of soluble, gypsiferous Mesozoic sediments in the recharge areas and contiguous alluvial fans in the southern portion of the Spring Mountains. Other factors contributing to the mineral content of ground water in this part of the Valley include longer time in the flow system, less annual recharge o water flux, and decreased permeability associated with finer-grained shale and siltstone bedrock and resulting detritus. In contrast, the central and northern portions of the Spring Mountains are composed primarily of Paleozoic carbonate strata with high secondary permeability, essentially no evaporites, and greater annual recharge due to higher average elevation. As a result, ground water is of higher quality.

In general, the pattern for TDS for the zone from 101 to 300 feet is one of progressive increase along the flow path. This is an expected and normal pattern because the dominant sink is the lowland area centered on Las Vegas Wash, the point toward which all ground water flows. The mineral content of deep ground water in the southeasterly portion of 21/62 increases from 1,000 to 3,000 mg/ℓ in a distance of about four miles. Comparing this with the change in the distance from the prime recharge area in the Spring Mountains to the 1,000 mg/ℓ contour line, (roughly 30 miles), gives an indication of the role played by the composition and permeability of fine-grained valley-fill.

The east-west trending zone of relatively good quality water extending across the northern portion of the study area to the central portion of 20/62, and then southward toward Boulder Highway is indicative of favorable conditions for ground-water development. These might include rather permeable sediments and/or significant ground-water inflow.

Warm ground water below depths of several hundred feet in the southern and southeastern portions of the study area also contributes to the dissolved solids in the shallow aquifers. Warm ground water and a mineral spa are present in 22/62-21. Water from an artesian well (LG002) 1,000 feet deep in section 4 of the same township varied from 22.2 to 33.5°C and contained between 3,127 and 4,660 mg/ℓ TDS when sampled in 1970. Other wells 300 feet deep or greater, with water containing in excess of 2,000 mg/ℓ TDS, are reported in 22/62, by Domenico and Maxey (1964) and Hardman and Miller (1934).

Sulfate concentrations in ground water at depths of 101 to 300 feet are shown in Figure 22 which is similar in pattern to the TDS plot discussed

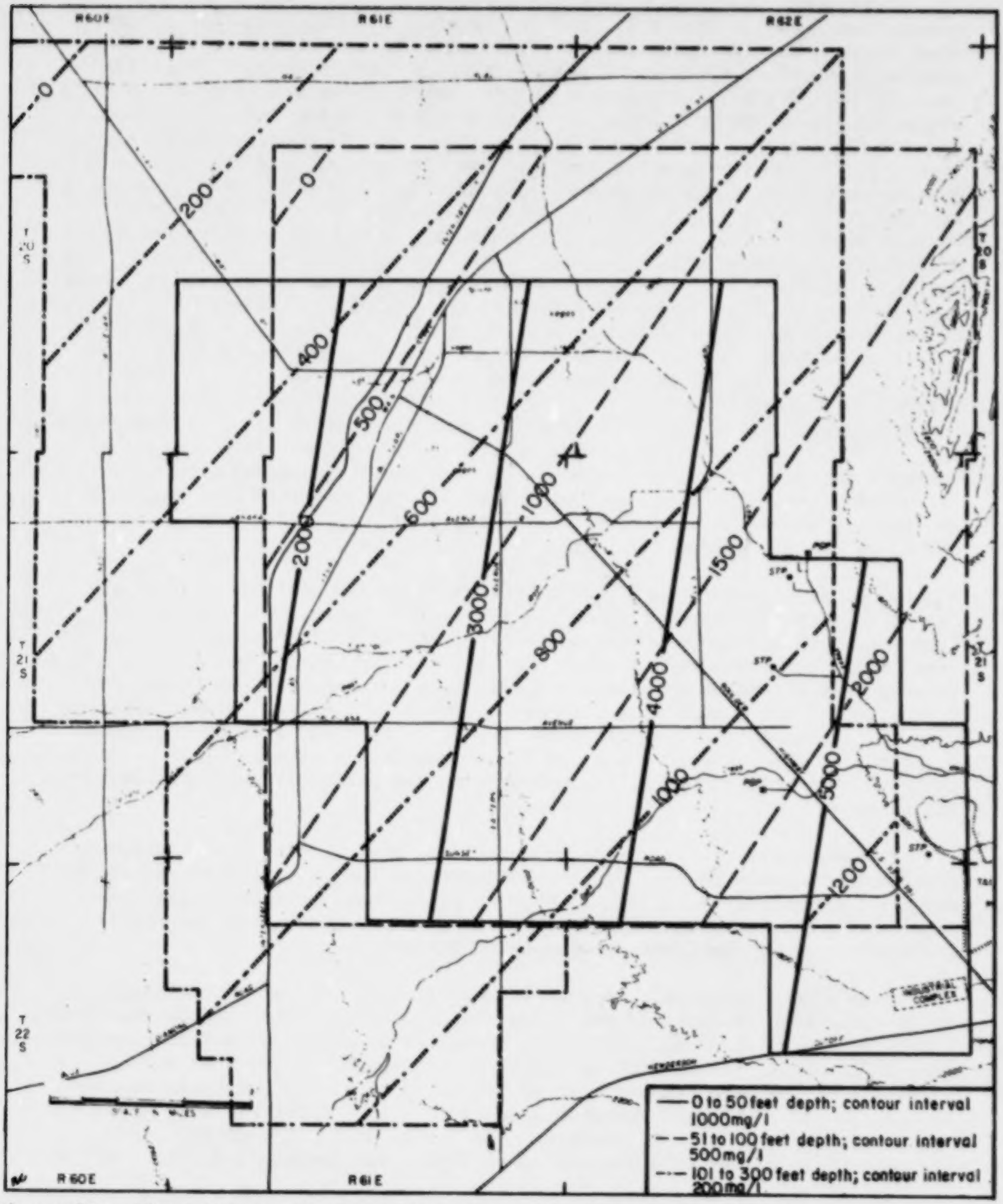

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
0
0
200
400
500
600
800
1000
1000
1200
1500
2000
2000
3000
4000
5000
STP
INDUSTRIAL COMPLEX
HENDERSON
R60E
R61E
0 to 50 feet depth; contour interval 1000mg/l
51 to 100 feet depth; contour interval 500mg/l
101 to 300 feet depth; contour interval 200mg/l

Figure 19. First degree trend surfaces for total dissolved solids in ground water at depths of 0 to 50, 51 to 100 and 101 to 300 feet deep.

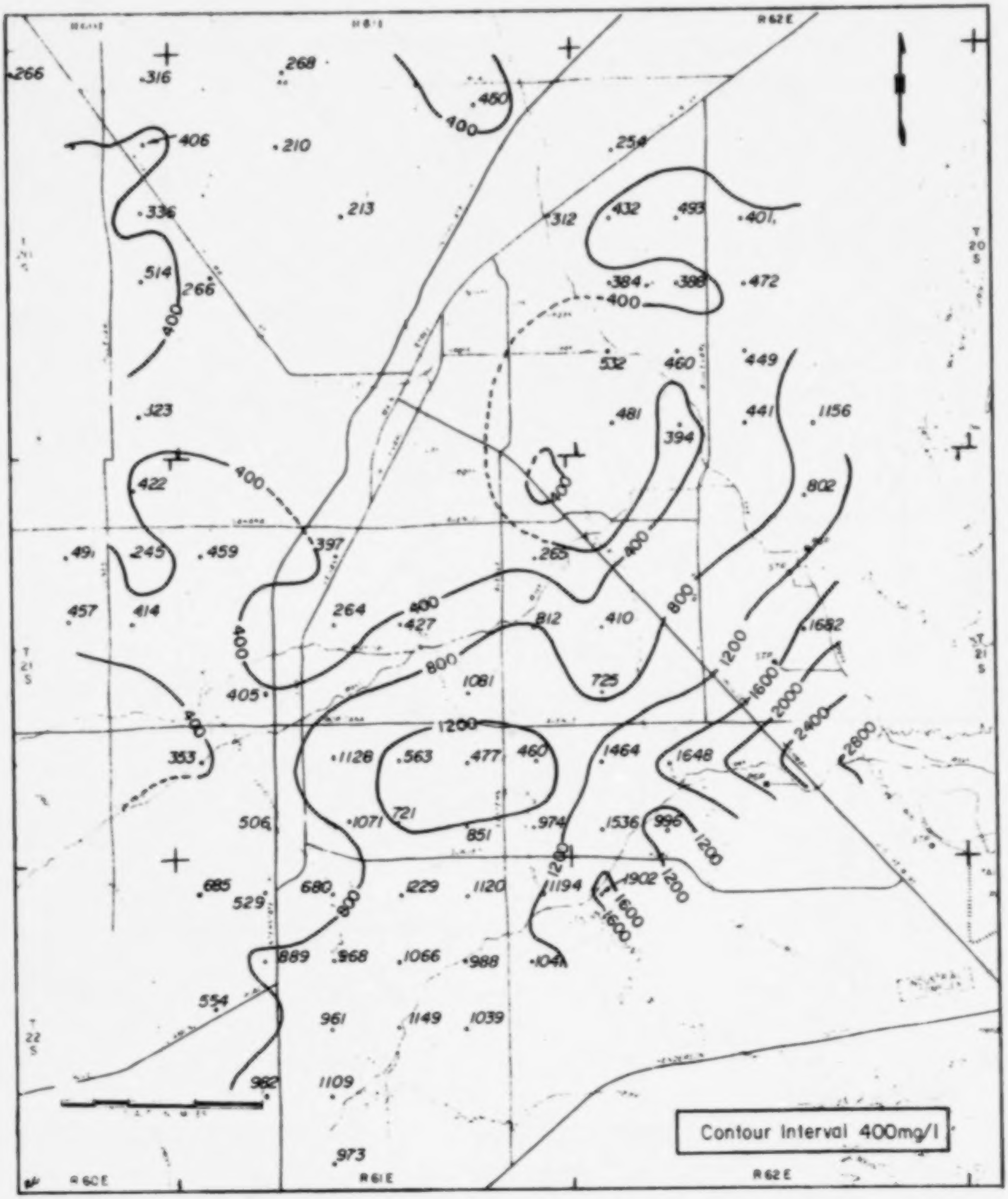

R62E
.266
.316
.268
.460
400
.406
.210
.254
.336
.213
.312
.432
.493
.401
.514
.266
400
.384
.388
.472
400
T 20 S
.532
.460
.449
.323
.481
.441
.1156
.394
.422
400
.802
.491
.245
.459
.397
.265
400
.457
.414
.264
400
.427
.812
.410
800
.1682
T 21 S
400
800
.1081
.405
.725
1200
1600
2000
400
1200
2400
.353
.1128
.563
.477
.460
.1464
.1648
2800
.506
.1071
.721
.851
.974
.1536
.996
1200
1200
.685
.529
.680
.1229
.1120
.1194
.1902
1200
1600
1600
800
.889
.968
.1066
.988
.1041
.554
T 22 S
.961
.1149
.1039
.982
.1109
.973
Contour Interval 400mg/l
R 60 E
R 61 E
R 62 E

Figure 20. Distribution of total dissolved solids in ground water at depths of 200 to 300 feet (manually contoured).

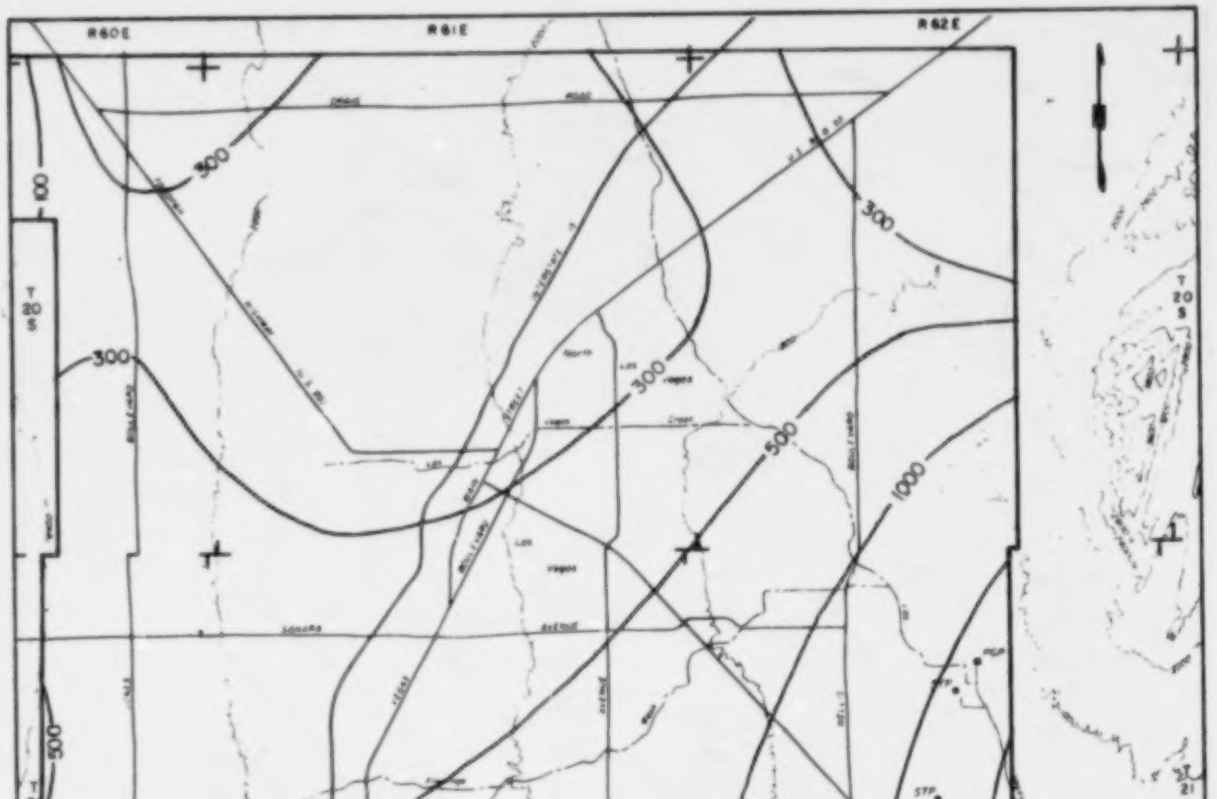

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
100
300
500
1000
2000
3000
STP
SCALE IN MILES
VARIABLE CONTOUR INTERVAL AS SHOWN, mg/l

Figure 21. Sixth degree trend surface for total dissolved solids in ground water at depths of 101 to 300 feet.

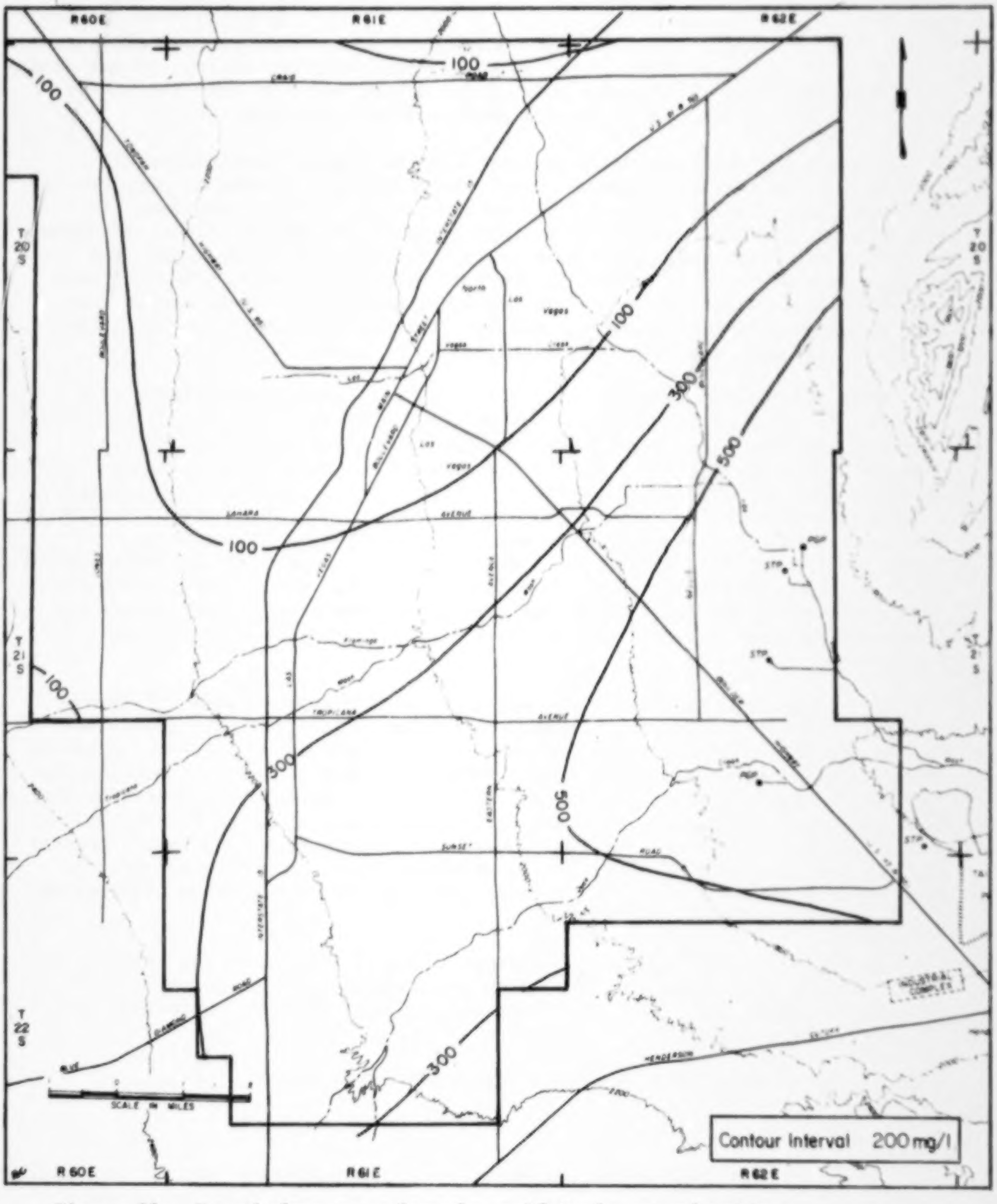

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
100
100
100
100
100
300
300
300
500
500
North
Las
Vegas
Las
Vegas
SAHARA
AVENUE
TROPICANA
AVENUE
SUNSET
ROAD
STP
STP
STP
SCALE IN MILES
INDUSTRIAL COMPLEX
HENDERSON
Contour Interval 200 mg/l

Figure 22. Fourth degree surface for sulfate in ground water at depths of 101 to 300 feet.

above. Minimum sulfate concentrations are associated with recharge entering the Valley from the north and northwest. Both the TDS and sulfate trends are indicative of minor inflow from the northwest flank of Sunrise Mountain. Inflow from the west, southwest, and south, particularly the latter, is enriched in sulfate with the result that most of the ground water in Paradise Valley does not meet the U.S. Public Health Service (1962) standard.

Nitrate and chloride trend surfaces had the lowest coefficients of correlation, indicating numerous local variations are present in comparison to broad, valley-wide trends for the parameters previously discussed. In general, the shallow aquifer, as defined by Maxey and Jameson (1948) at depths of 250 to 450 feet, contains 5 mg/ℓ or less nitrate. It is probable that wells in the depth range of 101 to 300 feet with greater than 5 mg/ℓ nitrate are either producing (in part) from the upper portion of the saturated zone and/or there is leakage along the casing. Data to check these possibilities were not available for all wells in question.

Distribution of chloride in ground water for the interval from 101 to 300 feet is also poorly described by the trend surfaces. As in the case of nitrate, numerous local variations are superimposed on the first order, regional trend (Figure 23). The latter depicts a concentration gradient of approximately 10 mg/ℓ per mile. Actual concentration in the southeast and northwest corners of the study area are 185 and 10 mg/ℓ, respectively. The low concentrations of chloride suggest prime recharge to the alluvial fill comes from source area(s) low in chloride and is characterized by short residence time, or relatively short flow paths, or both. This in turn, suggests that recharge to the valley fill may also be associated with movement in the carbonate aquifers rather than only in the alluvial aprons flanking the carbonates.

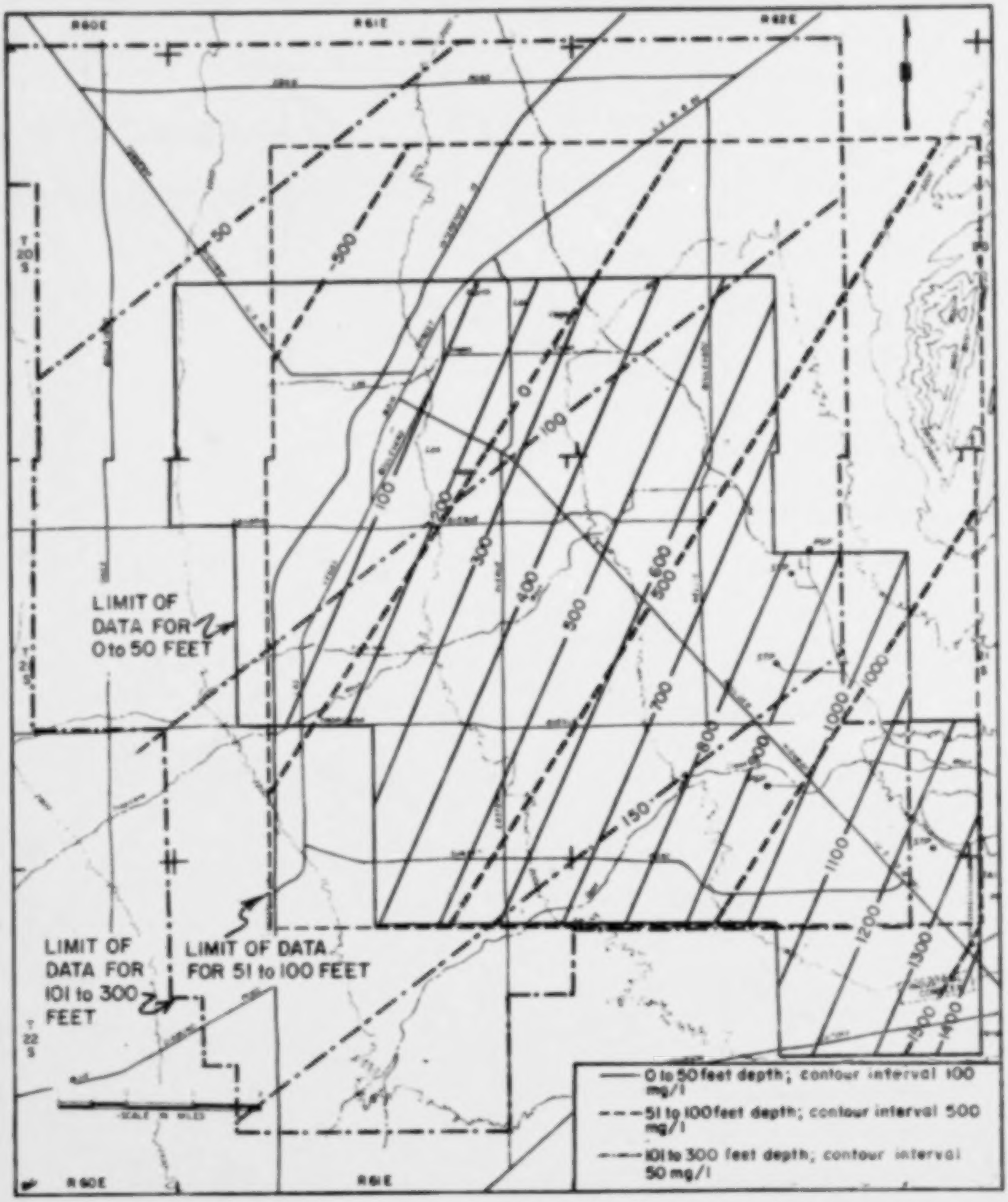
It is apparent from the first order chloride trends (Figure 23) that absolute concentrations at any point and concentration gradients across the Valley are very dissimilar for the three depth intervals considered. Markedly more saline conditions prevail in the interval from 0 to 100 feet and largely reflect natural conditions, primarily concentration by evapotranspiration and the presence of saline soils. Both influences are apparent in the interior portion of the Valley characterized by shallow depths to ground water, phreatophytes, and fine-grained playa facies sediment types. However, man-related factors such as waste disposal are also operative and are dominant influences in the eastern part of the Valley.

In terms of water quality, the depth interval from 51 to 100 feet can be considered as transitional. This, plus the scarcity of data points (as reflected in Figure 24), justifies discussion of this zone in conjunction with the overlying and underlying intervals.

SHALLOW GROUND-WATER QUALITY (depth interval 0 to 50 feet)

Effects of Soil and Runoff

Water quality in the near surface zone within the study area is generally poor. The salts present are a result of concentration by evaporation and transpiration from areas with a high water table and former marshy areas,



R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
50
500
0
100
100
200
300
400
500
600
500
700
800
900
1000
1000
150
1100
1200
1300
1400
1500
LIMIT OF DATA FOR 0 to 50 FEET
LIMIT OF DATA FOR 101 to 300 FEET
LIMIT OF DATA FOR 51 to 100 FEET
0 to 50 feet depth; contour interval 100 mg/l
51 to 100 feet depth; contour interval 500 mg/l
101 to 300 feet depth; contour interval 50 mg/l
R60E
R61E

Figure 23. First degree trend surface for chloride in ground water at depths of 0 to 50, 51 to 100, and 101 to 300 feet.

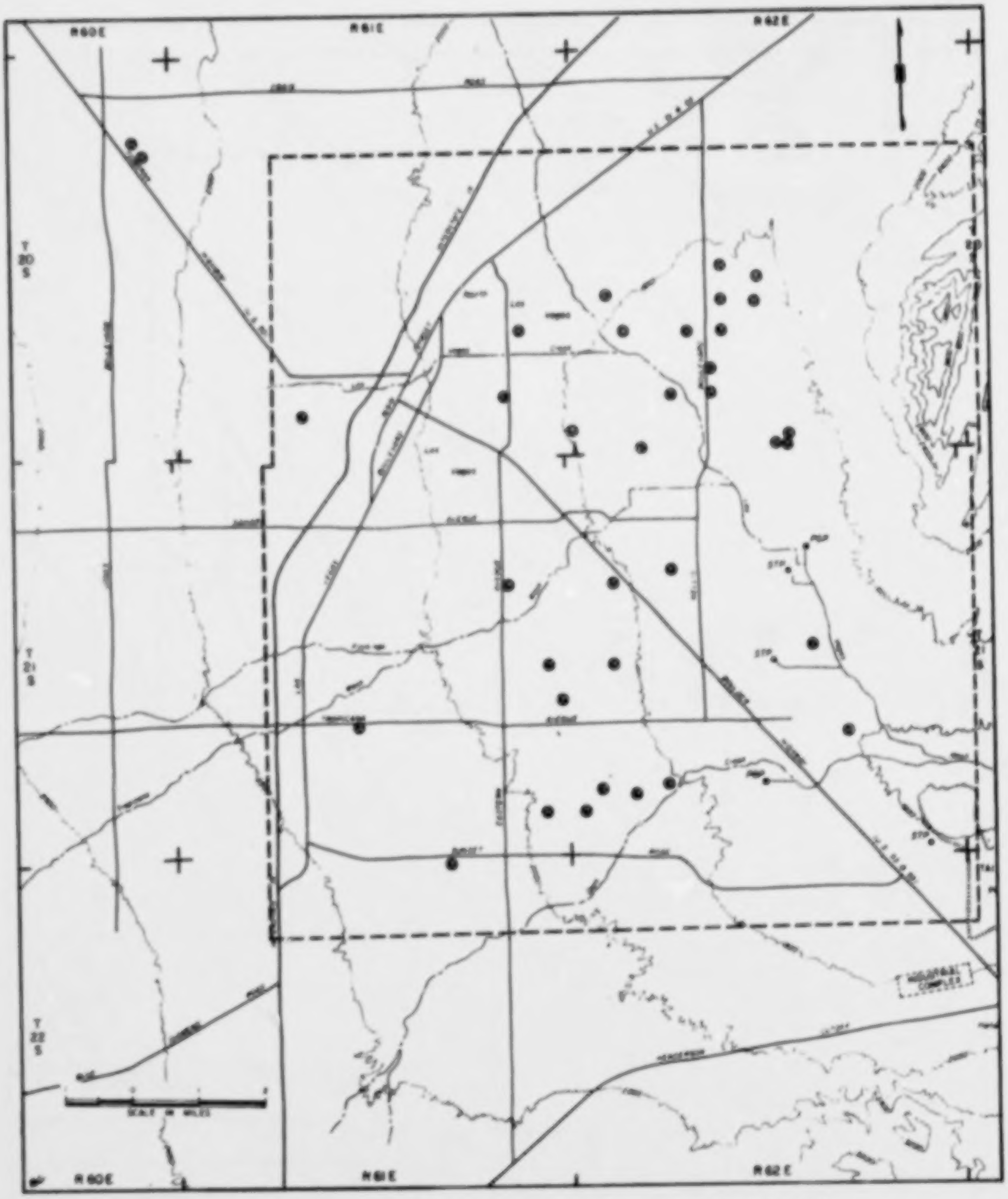

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
STP
SCALE IN MILES
R60E
R61E
R62E

Figure 24. Locations of wells used to characterize ground-water quality at depths of 51 to 100 feet.

streams, and possibly shallow lakes or ponds. Dissolution of the valley fill, sulfate in particular, is also a contributor. Sulfate in the form of gypsum is abundant in the Mesozoic sediments in the southern end of the Spring Mountains and in the Sunrise Mountain and Rainbow Garden areas to the east. Urbanization and associated lawn watering plus limited agricultural development have leached the salts in the soil profile directly as a result of return flows or indirectly as a result of a rising water table. The latter phenomenon is most pronounced in the vicinity of Las Vegas Wash. Definition of the effects on ground-water quality due to modifications in soil profiles, greatly increased return flows from irrigation water, and altered runoff patterns associated with developed versus undeveloped areas was not possible. However, a general understanding of probable influences merits discussion.

An indication of the role soil conditions should have on surface water and shallow ground-water quality can be seen by comparing the distribution and characteristics of major soil groups (see Figure 25 and Table 2) as defined by Langan et al. (1967). The major soil associations reflect distinctive landscape forms, parent materials, and patterns of individual soil types. For example, the Glendale-Land association is restricted to the level or nearly level valley floor. It is moderately to well drained and capable of supporting irrigated crops. The parent materials are primarily recently reworked, fluvial and(or) floodplain sediments . The Badland-Bracken-McCarran soil association, on the other hand, is derived from fine-grained sediments associated with distal ends of alluvial fans or with former lakes or sluggish, through-moving drainage in late Pleistocene time. Medial portions of the fans contain very shallow, medium to coarse-grained soils underlain by well cemented gravel or caliche. These are represented by the Cave-Goodsprings-Las Vegas and the Tonopah-Pittman-Eastland-Jean associations. Soils in the Skyhaven-Spring-Gass association are somewhat intermediate in character between those developed on the fans and those on playa materials. They are fine to medium grained, relatively shallow, moderately to strongly mineralized and locally underlain by a limey hardpan.

In summary, the floodplains of the major washes contain less saline, very deep loamy soils. Between the dominant drainage courses are the highly gypsiferous, deep loamy soils. These are bounded on the north by the Skyhaven-Spring-Gass association developed on level and gently sloping terraces consisting of loamy clayey soils and underlain by a hardpan. It is likely under predevelopment conditions, that overland flow across the gypsiferous soils on the interfluves resulted in significant salt removel.

Generally, medial portions of the alluvial fans surrounding the developed areas of the Valley, and contributing significant runoff to urbanized areas during intense, but localized, precipitation events, are characterized by low infiltration rates. This is attributed to the presence of caliche and cemented gravel hardpans. From a study of caliche development and the effects on runoff and infiltration on the Red Rock Canyon fan, Cooley et al. (1973) concluded that caliches on four representative physiographic units within the fan apron as far east as 21/61-3ab have infiltration rates equivalent to stratified or unweathered clay, i.e., essentially impervious. Throughout most of the developed area in the Valley the native soils present severe limitations on the use of septic tanks (Table 2) which is also indicative of low permeability within five feet of the land surface.

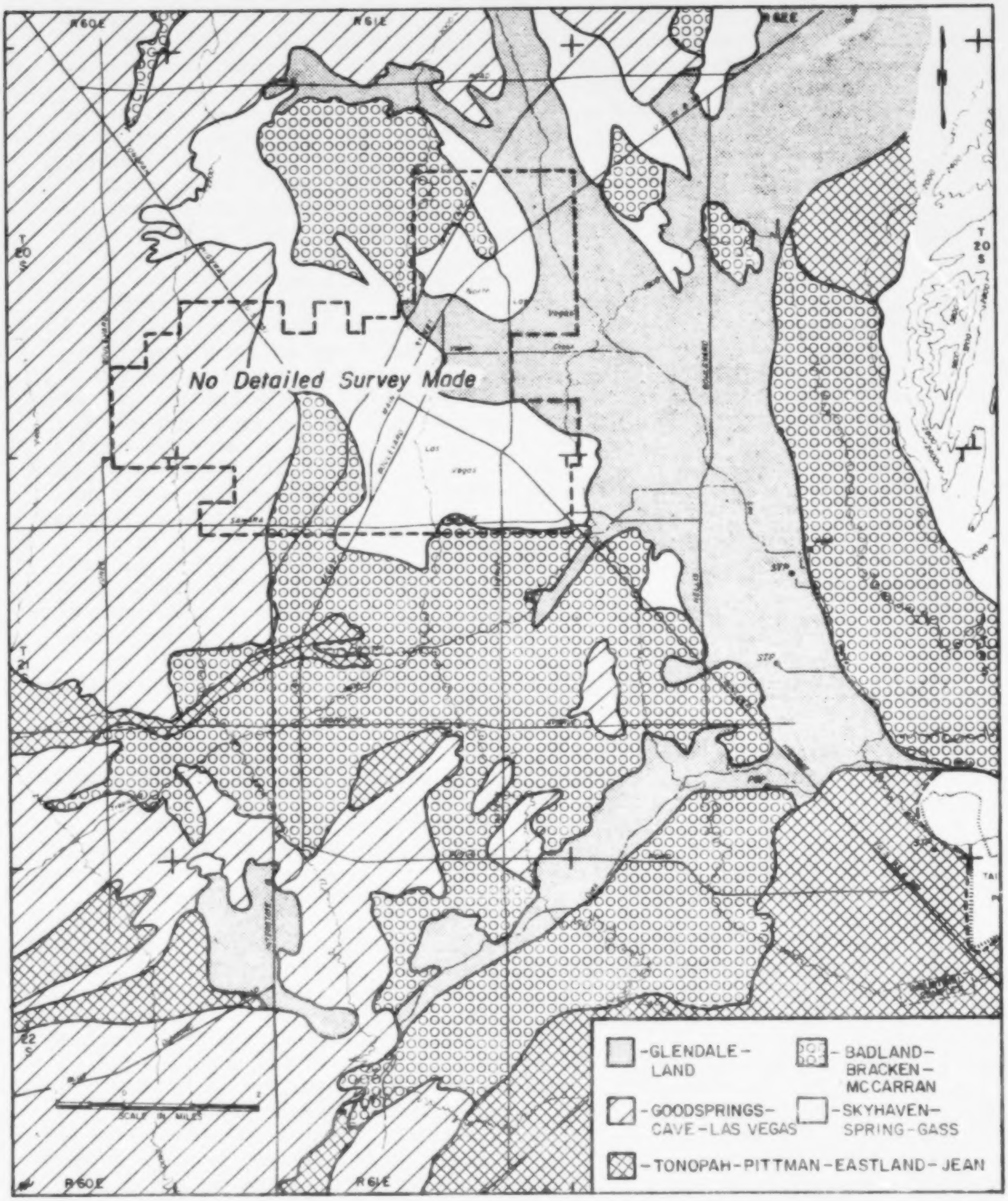

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
No Detailed Survey Made
North Las Vegas
Las Vegas
SCALE IN MILES
-GLENDALE-LAND
-BADLAND-BRACKEN-MCCARRAN
-GOODSPRINGS-CAVE-LAS VEGAS
-SKYHAVEN-SPRING-GASS
-TONOPAH-PITTMAN-EASTLAND-JEAN

Figure 25. Map of the major soil associations in Las Vegas Valley.

TABLE 2. SUMMARY OF THE CHARACTERISTICS OF MAJOR SOILS IN LAS VEGAS VALLEY*

Soil Association	Soil Name and Characteristics	Unified Classification	Septic Tank Limitation
Glendale-Land	"Very deep loamy soils on nearly level floodplains" Glendale soils constitute 60 percent of the association and are well drained, medium textured, strongly calcareous, and moderately or slowly permeable. Land soils constitute 20 percent of the association and are well drained, moderately fine to medium textured, unusually high in crystalline salt and gypsum and moderately slowly or slowly permeable.	ML, GP, SM, CL	Moderate-Severe
Badland-Bracken-McCarran	"Deep and very deep, loamy and gravelly, highly gypsiferous soils on nearly level to moderately sloping terraces and on eroded, moderately sloping to strongly sloping terrace escarpments" Badland makes up about 35 percent of the association and consists of highly gypsiferous, calcareous, lake laid silts and clay. Bracken and McCarran soils each constitute 32 percent of the association and are well drained, gravelly, moderately coarse textured and high in gypsum.	CL/ML, CL, SC, CH	Severe
Cave-Goodsprings-Las Vegas	"Shallow and very shallow gravelly and loamy soils on nearly level and gently sloping terraces. Commonly underlain by hardpan or cemented gravel" Cave soils constitute 35 percent of the association which occupies 35 percent of the Valley. Cave soils are very shallow to shallow, moderately coarse textured, and overlie a thick calcareous hardpan. Goodsprings soils make up 30 percent of the association and are shallow to shallow,medium textured and overlie a thick, calcareous hardpan. The hardpan underlying these soils inhibits installation of offsite improvements and cannot be ripped. The soils are well drained but have very shallow root zones and low water holding capacity.	SM, SC, ML, CL	Severe
Skyhaven-Spring-Gass	"Shallow to deep loamy and clayey soils on nearly level and gently sloping terraces; shallow soils underlain by a hardpan." Skyhaven soils form 50 percent of the association. These are well drained, calcareous, moderately fine textured, and overlie a calcareous hardpan. Spring soils, forming 37 percent of the association, are imperfectly drained, moderately fine textured, high in gypsum and calcite. Gass soils are moderately well drained, fine textured, calcareous.	CL, SM, CH	Severe
Tonopah-Pittman-Eastland-Jean	"Very deep to shallow,gravelly sandy and gravelly loamy soils on nearly level to strongly sloping alluvial fans; shallow soils underlain by a hardpan". This association is most prominent as scattered spots on the alluvial fans surrounding the Valley. Tonopah soils, forming 37 percent of the association, are very gravelly, coarse textured, calcareous, and excessively drained. Pittman soils form 37 percent of the association and are very coarse textured, calcareous, and well drained. Jean and Eastland soils each constitute 13 percent and are coarse textured, well to excessively drained, and moderately deep over gravelly parent material.	GW, GP, SM, GM, GW	None

* Adapted from Langan et al., 1967.

The role of sheet runoff as a mechanism for removing surficial salts from the soils is evident from Table 3 which was developed from a U.S. Geological Survey (1972) study within the city limits of Las Vegas.

TABLE 3. AREAS SUBJECT TO FLOODING IN THE CITY OF LAS VEGAS

Zone	Description	Area (square miles)
A	Subject to inundation by the base (100-year) flood	8.58
B	Subject to inundation by the 500-year flood, but not included in Zone A	1.36
B1	Subject to inundation by sheetflow which may occur at any time	26.39

Areas under Clark County jurisdiction are excluded, hence flooded areas associated with the major washes, with the exception of Las Vegas Creek, are not reflected in the figures shown above. The total area subject to flooding and sheetflow in the Valley is unknown but can be estimated from the drainage areas and projected floods for the major washes (Table 4). In terms of geologic time, the Lesser, Intermediate Regional, and Standard Project Floods and associated sheet runoff are likely to have occurred many times, thereby removing much of the surficial accumulations of salt.

TABLE 4. PEAK DISCHARGES ASSOCIATED WITH FLOODS IN LAS VEGAS VALLEY*

Drainage Course	Drainage area square miles	Peak discharge (cfs) associated with the following floods: Lesser	Intermediate Regional	Standard Project
Lower Las Vegas Wash	1,571	27,000	39,000	100,000
Duck Creek	1,510	26,500	38,500	98,000
Flamingo Wash	1,000	23,000	34,000	83,000
Las Vegas Creek	807	22,000	31,500	77,500

* Taken from U. S. Army Corps of Engineers (1967).

Intense urban and suburban development in the Valley covers an area of roughly forty square miles. Within this area many of the tributary and distributary channels have been filled in resulting in increased overland and overstreet flood flows associated with intense, short duration storms most common as thunderstorms in July and August. Numerous channel improvements, particularly in certain reaches of Las Vegas Wash, Flamingo Wash, and most recently, Las Vegas Creek have alleviated flooding problems in local areas but a significant drainage problem remains according to Cooley et al. (1973), Jones (1972), and the U. S. Army Corps of Engineers (1967).

At numerous locations former dry wash channels have been encroached upon and even filled to make room for structures. Figures 26 through 29 illustrate a typical situation where a natural wash channel has been covered with a housing development. Overland flow from the development is at least partly returned to the Wash, as storm sewers are nonexistent. "Improvements" of the same channel in the downstream direction can be seen from comparing Figures 27 and 28, taken west and east, respectively, where the Wash crosses Eastern Avenue. Note the drastic reduction in channel capacity between the natural and "improved" state. To allow more development, land has been leveled on either side of the "improved" channel (see Figures 28 and 29). The channel has been completely filled in preparation for construction of another development still further downgradient.

With the exception of areas underlain by thick, competent caliche at very shallow depths, construction of areally extensive housing tracts, is

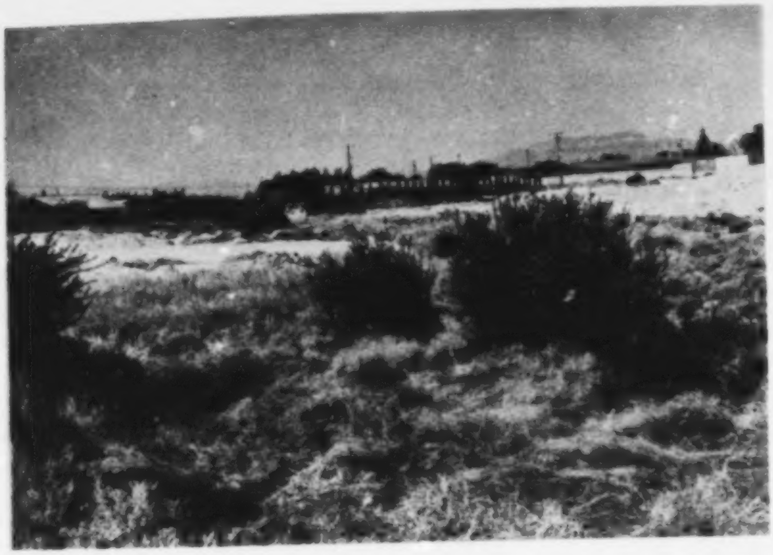


Figure 26. Photograph of an unimproved wash channel in the vicinity of Harmon and Eastern Avenues. Note that the subdivision in the background straddles the wash.

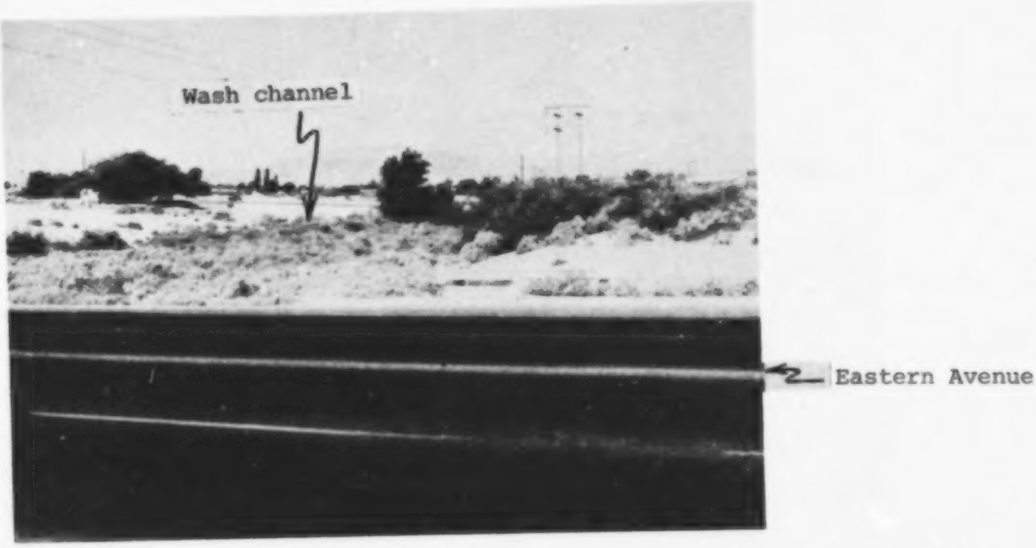


Figure 27. Photograph of an unimproved wash channel immediately west of Eastern Avenue and south of Rochelle Avenue.

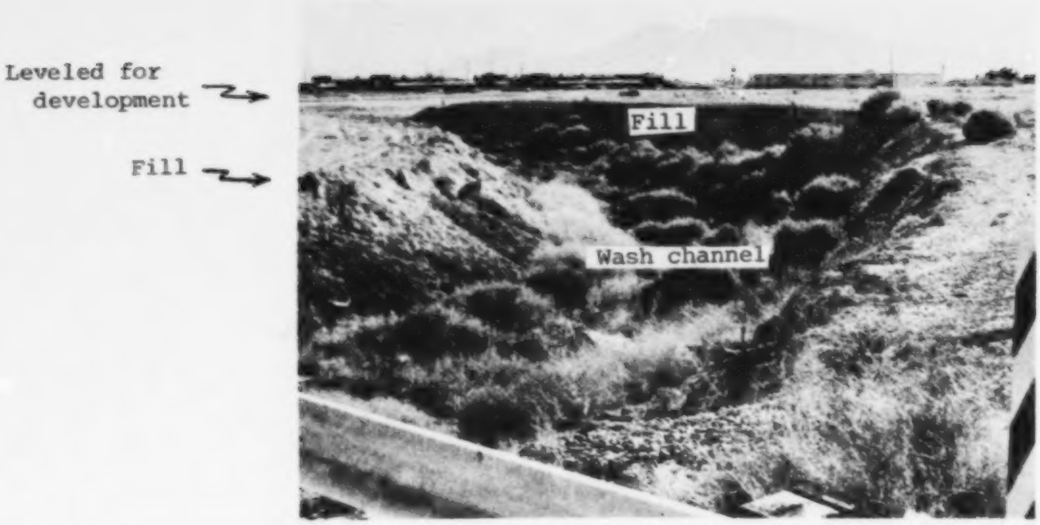

Leveled for development
Fill
Fill
Wash channel

Figure 28. Photograph of the dry wash in Figure 27 showing channel encroachment as a result of fill operations in the area east of Eastern Avenue and south of Rochelle Avenue. Note the reduction of floodplain by earth fill.

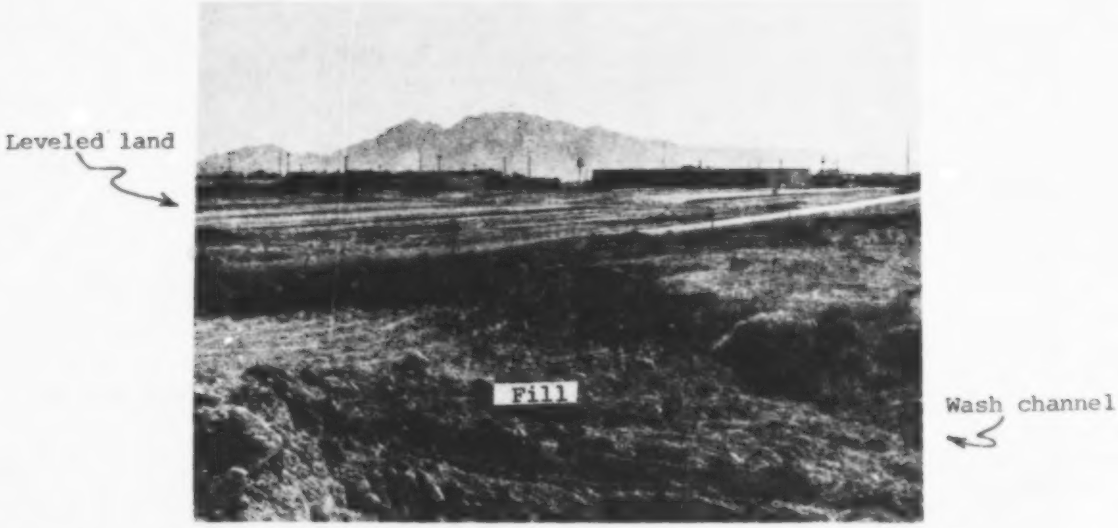

Leveled land
Fill
Wash channel

Figure 29. Terminus of the wash shown in Figures 27 and 28 in a proposed housing development. Note the absence of stream channel in the leveled land and the lack of a culvert beneath the street.

preceded by deep leveling and grading (Figure 30) to provide proper gradients for sanitary sewers and storm runoff and to remove expansive soils laden with mirabilite and thenardite that are damaging to foundations. After construction the subsequent development becomes an area of recharge due to return flows from irrigation. Patt (1977) has shown that annual recharge from such areas is on the order of 6 to 11 acre feet per acre.

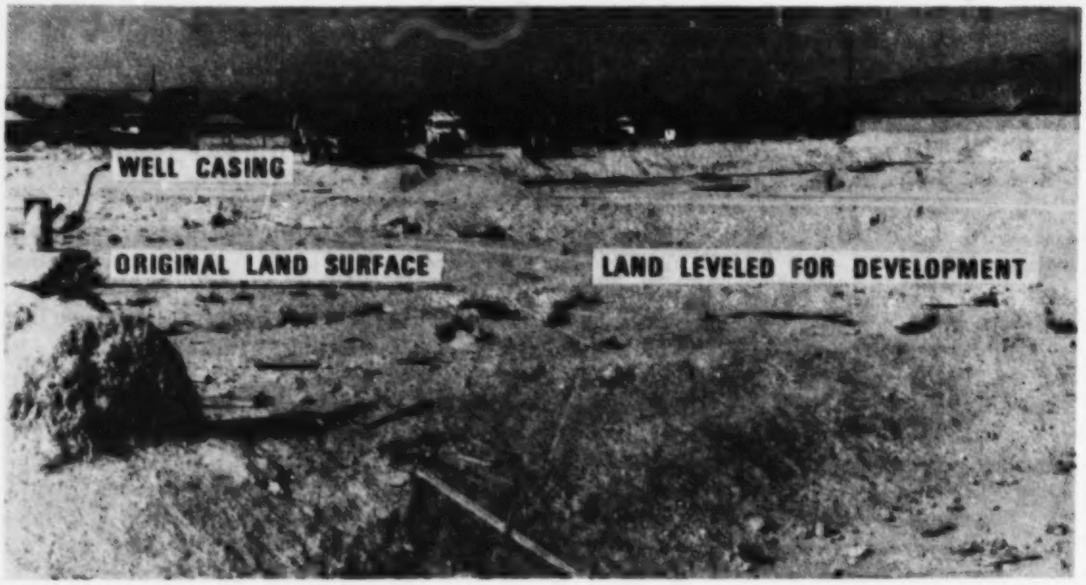


Figure 30. Photograph showing typical soil excavation and land leveling in preparation for constuction of a subdivision.

To summarize, rapid urban and suburban growth in Las Vegas Valley for about thirty years has involved consistent disruption of natural drainage paths and associated salt flux processes in the native soils. For overland and open channel flow, the net effect has been to collect and channelize flow through urban portions, totally impede and block sheet flow, and to reduce the discharge capacity of lesser tributaries. This has led to localization of runoff and increased local recharge to the near surface zone. Similarly removal of caliche layers and hardpans, together with nonpoint wastewater return flows, increases the leaching of saline soils, and increases salinity in shallow ground water. Increased infiltration of poor quality overland flow and concentration of diffuse ground water in permeable sediments of modern channels and ancestral washes is documented in this study using nitrate and tritium data.

Impacts of Return Flows on Shallow Ground-Water Quality

Nitrate, chloride and TDS concentrations are particulary diagnostic of return flows associated with urbanized portions of the Valley, areas of sewage disposal, areas irrigated with sewage, and the industrial area at Henderson. Detailed documentation of water use and return flows presented in this study and by Malmberg (1965) reveal returns from sewage effluent, industrial wastes, cooling water, and septic tank systems have infiltrated the near surface aquifer.

As early as 1912, effluent from the original Las Vegas sewage treatment plant at Ninth Street and Harris Avenue was used for irrigation on the Stewart Ranch located in the flat area now occupied by Lions Park and Fantasy Park. Treatment plants were successively established in 1931 at 15th Street and Harris Avenue, in 1942 at 25th Street and Harris Avenue, in 1948 at Harris Avenue and Manning Street, and in 1956 at Vegas Valley Drive and Monson Road. Primary effluent from the 1931 plant was used for irrigation until 1948 when the plant closed. From 1948 to the present, effluent from the plants built in 1948 and 1956 was used to irrigate acreage east of what is now the Winterwood Golf Course (L. Anton, City of Las Vegas, oral communication).

In 1955, 7,000 acre feet of effluent infiltrated in the eastern part of the Valley. Whereas recharge to the near surface aquifer over the entire Valley was estimated at 14,000 acre feet per year by Malmberg (1965) and about 18,000 acre feet by Patt (1977). From 1955 to 1969, water levels in the vicinity of the Clark County Sewage Treatment Plant rose about 14.6 feet, or 1.04 feet per year, largely as a result of the irrigation of alfalfa with sewage effluent in the surrounding area. The Soil Conservation Service noted that for 1,130 irrigated acres surrounding the City and County treatment plants, the water table was six feet or less from the land surface in 43 percent of the area (Stains, 1970). At the present time, there are over 5,000 acres in the Valley being irrigated with 43,000 acre feet per year, only a third of which is consumptively used.

Sewage effluent applied to the Paradise Valley and Winterwood golf courses since 1960 and 1965, respectively, has caused little change in TDS, but nitrate in shallow ground water increased to as much as 140 mg/ℓ at stations LW015 and LW099. In the vicinity of the City and County sewage treatment plants, TDS is on the order of 4,000 to 6,000 mg/ℓ which is not markedly different than background in this area. Nitrate, however, is much elevated and typically varies from 90 to 130 mg/ℓ in wells LG037, 060, and 128. Phosphate in the latter is 8.8 mg/ℓ or approximately 88 times normal background concentration.

Sewage effluent from individual treatment plants associated with several major hotels also contributed to nitrate concentrations in ground water. Beginning in 1944 an Imhof tank and oxidation lagoons were used at the Last Frontier Hotel on the Las Vegas Strip. The ponds proved to be under capacity and thereafter until 1954 the combined effects of evaporation and infiltration disposed of 50,000 to 100,000 gallons of effluent per day (G. B. Maxey, oral communication). During this period and particularly after 1954, the District Health Department noted contaminated wells in the area. The Flamingo Hotel, built in 1947, had onsite treatment facilities and an outfall line which allowed effluent to flow along Flamingo Raod and infiltrate and evaporate in the desert. At the Tropicana Hotel a treatment plant was built and the effluent was used on its nine-hole golf course. Any excess was held in detention ponds at the site of the present day Paradise Hotel. Effluent from a treatment plant constructed at the Desert Inn in 1950 was similarly used for irrigation and filling a lake on the golf course. Effluent from the Sands Hotel was formerly used for golf course irrigation or allowed to flow to the nearby desert. Prior to 1955, effluent from an activated sludge plant was used for irrigation of the Dunes Hotel golf course.

Septic tanks are also believed to be a significant source of nitrate contamination. By 1973 approximately 4,000 septic tank installations were known in the Valley and contributed an estimated 1,750 acre feet per year of wastes to the near surface aquifer (Patt, 1977).

Other miscellaneous nitrate sources include the LDS Church Farm and adjacent farms. Located between the City and County Sewage Treatment Plants, an area of about 1,160 acres has been irrigated with effluent since 1957. The sewage treatment plant at Nellis Air Force Base operated from 1940 to 1971. Leakage from the lagoons and return flow from the nine-hole Base golf course, which was partially irrigated with effluent until 1971, have contributed to anomalous nitrate concentrations in the area immediately south of the oxidation lagoons. This is an area that otherwise has relatively high quality water in the upper 300 feet of valley fill.

The importance of other sources of nitrate such as fertilizers, buried evaporites, and leaky sewer lines is poorly understood but believed to be minor. Another source may be the oxidation of buried organic mats associated with depostis at springs in the northwestern part of the Valley where nitrate concentrations in shallow ground water in the last few years have gone from less than 5 mg/ℓ to 450 mg/ℓ and are cause for concern. Detailed studies of this phenomenon are being conducted (Patt and Hess, 1976). The effects of livestock, horses in particular, is unknown but may be locally significant considering that 10,000 horses are estimated in the Valley.

Because numerous sources of nitrate are or have been present, concentrations in ground water were initially analyzed through use of trend surfaces to ascertain variations for depth intervals 0 to 50, 51 to 100, and 101 to 300 feet. The second approach consisted of plotting nitrate levels equal to or greater than 10 mg/ℓ and comparing the results with known distributions of septic tank and cesspool waste disposal systems and areas of sewage disposal. In a negative fashion, the trend surfaces for nitrate (Figures 31 and 32) proved to be rather revealing. Concentrations above 10 mg/ℓ in the zone from 0 to 50 feet are common, particularly in the eastern part of the Valley. In contrast, nitrate at depths of 101 to 300 feet is irregularly distributed and generally quite low in concentration. This implies that waste disposal, and primarily that in the eastern part of the Valley, dominates the shallow nitrate pattern.

The threshold value of 10 mg/ℓ was selected to distinguish between background and polluted levels of nitrate. The value is arbitrary but conservatively so because natural values average less than 5 to 7 mg/ℓ according to raw data plots and trends initially generated. By determining deviations from background and relating them to causal factors of land and water use, conclusions can be drawn concerning the impact of septic tanks and other sources of nitrate pollution on shallow ground-water quality.

In the course of calculating the return flows to the near surface aquifer, highly detailed maps of areas served by on-site disposal facilities were prepared by Patt (1977) from an examination of septic tank permits issued by the Clark County Health Department. Indirect confirmation of this approach for the period 1943-1972 was made by using aerial photographs and comparing developed areas versus areas served by the City and County Sanitation Districts.

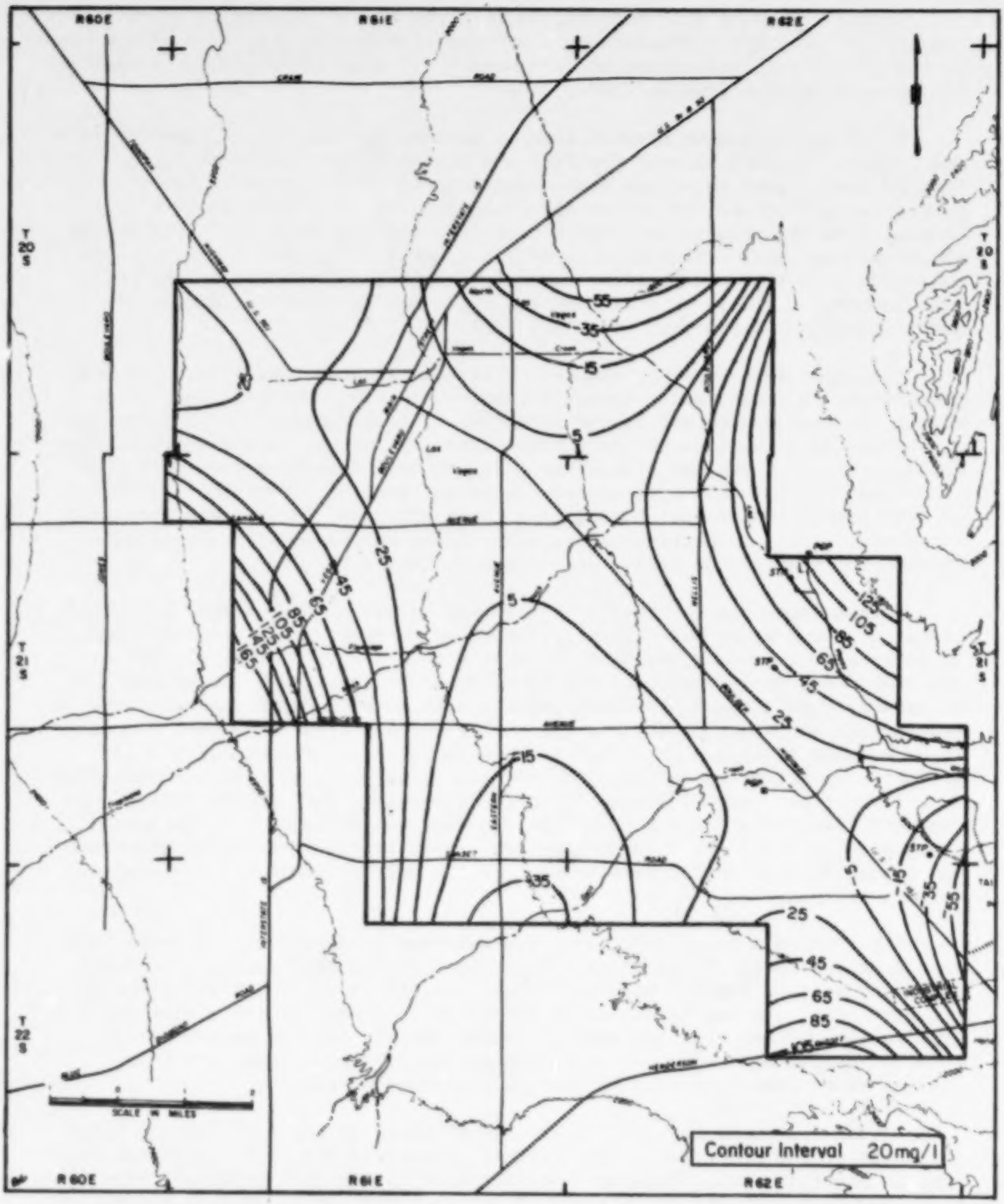

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
55
35
15
5
25
45
65
85
105
125
145
165
5
15
135
25
45
65
85
105
125
105
85
65
45
25
5
15
35
55
SCALE IN MILES
Contour Interval 20mg/l

Figure 31. Fifth degree trend surface for nitrate in ground water at depths of 0 to 50 feet.

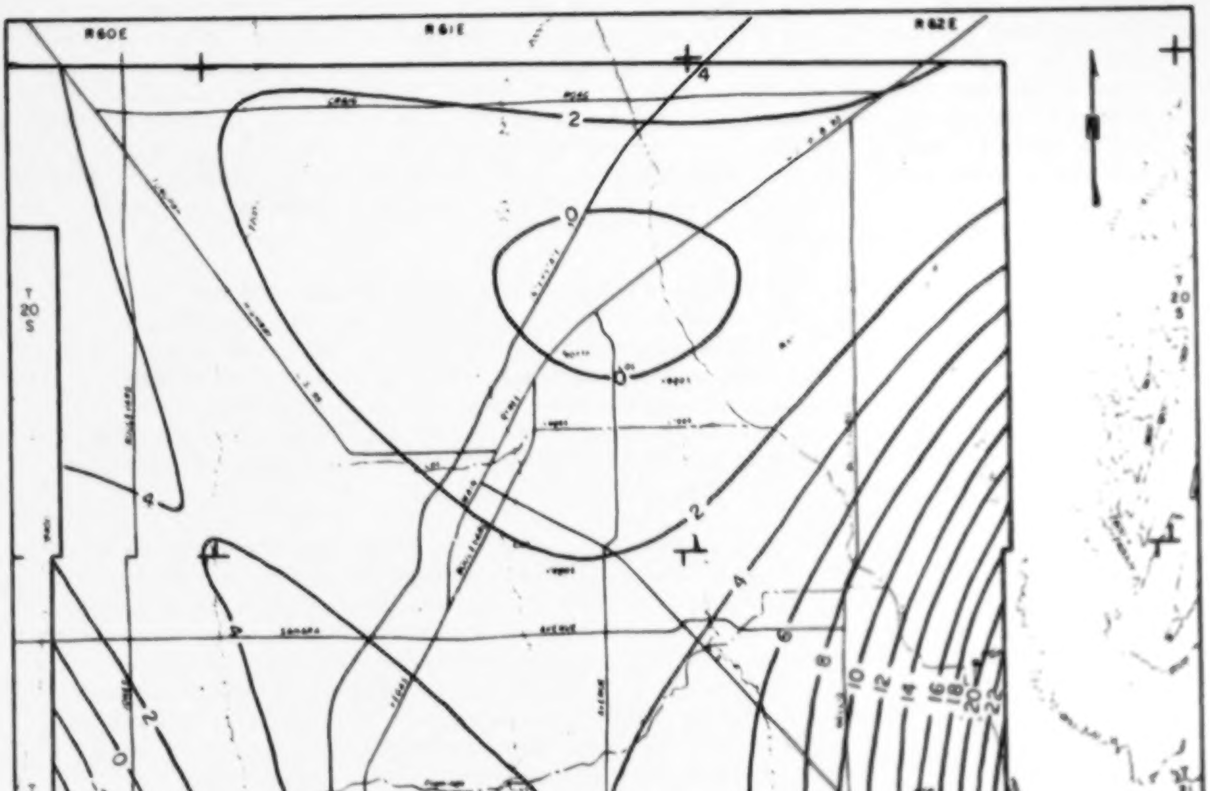

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
SCALE IN MILES
Contour Interval 2 mg/l
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
-2
-4
-6

Figure 32. Fourth degree trend surface for nitrate in ground water at depths of 101 to 300 feet.

Developed areas not served by sewers were assumed to contain septic tanks. A generalized version of the detailed maps plus nitrate concentrations in ground water is shown in Figure 33. Also shown are additional areas which are or were recharged with wastewater. These areas were identified from previous reports (Maxey and Jameson, 1948; Leeds, Hill and Jewett, 1961; Malmberg, 1965; Boyle et al., 1969 a, b) and from interviews with local officials and hotel personnel (see Patt, 1977). High nitrate concentrations from industrial and sanitary waste return flows in the vicinity of the lower reach of Las Vegas Wash are discussed separately.

It is evident that distribution of septic tank disposal systems is irregular but widespread. The distribution is indicative of the suburban sprawl, or "leapfrog" form of development which typifies surburnan growth in Las Vegas. Numerous developments with on-site sewage disposal and either public water supply or individual wells have been and will continue to be common in the Valley. Although the volume of return flow from such sources is relatively small, the water quality effects in terms of higher concentrations of nitrate are readily noticeable.

In the zone from 101 to 300 feet deep, nitrate typically averages five mg/ℓ or less and rarely exceeds the arbitrary limit of 10 mg/ℓ. Slightly higher average concentrations for the same depth zone are evident in domestic wells in the area between Warm Springs Road on the north and Paradise Spa to the south. For the period from 1965 to January 1968 there are only about a dozen values greater than 10 mg/ℓ for this area. Insofar as development was minor prior to 1968, nitrate is apparently a recent addition and attributable to the rapid proliferation of septic tanks and, possibly, horses in an area of granular soils and a gradually declining water table. In general, horses in the Valley are coincidentally located in areas served by septic tank disposal systems.

Ground water in those portions of Paradise Valley east of Eastern Avenue is generally under slight artesian head, hence return flows of any type are unlikely to affect ground-water quality at depth. Comparison of the pre- and post-1968 nitrate data for the central and western portions of the Valley reveals that more recent analyses tend to be higher. The pre-1968 data are commonly associated with nitrate sources that are now inactive. These include areas with septic tank disposal systems which were converted to municipal sewer systems or areas used for sewage disposal only for a short period as in the case of certain Strip hotels. Nitrate concentrations of 10 to 158 mg/ℓ associated with recent developments in the northwestern part of the study area attest to the rapidity with which septic tank leachate appears in ground water, probably due to faulty well seals. Thin but extensive permeability barriers in the vadose zone contribute to lateral flow and surfacing.

Nitrate concentrations exceeding 10 mg/ℓ in the interval from 0 to 100 feet are not well known. Domestic wells in this depth range were drilled in the early 1950's to effect necessary land improvements and thereby gain title to acreage released under the Desert Land Entry Act. Most of these wells were never sampled or were destroyed, hence water quality data are scarce. Wells of this type were relatively shallow and many have gone dry as a result of heavy pumping on the west side of the City. Thus, for a variety of reasons, limited data exist concerning very shallow water quality at depths of 0 to 100

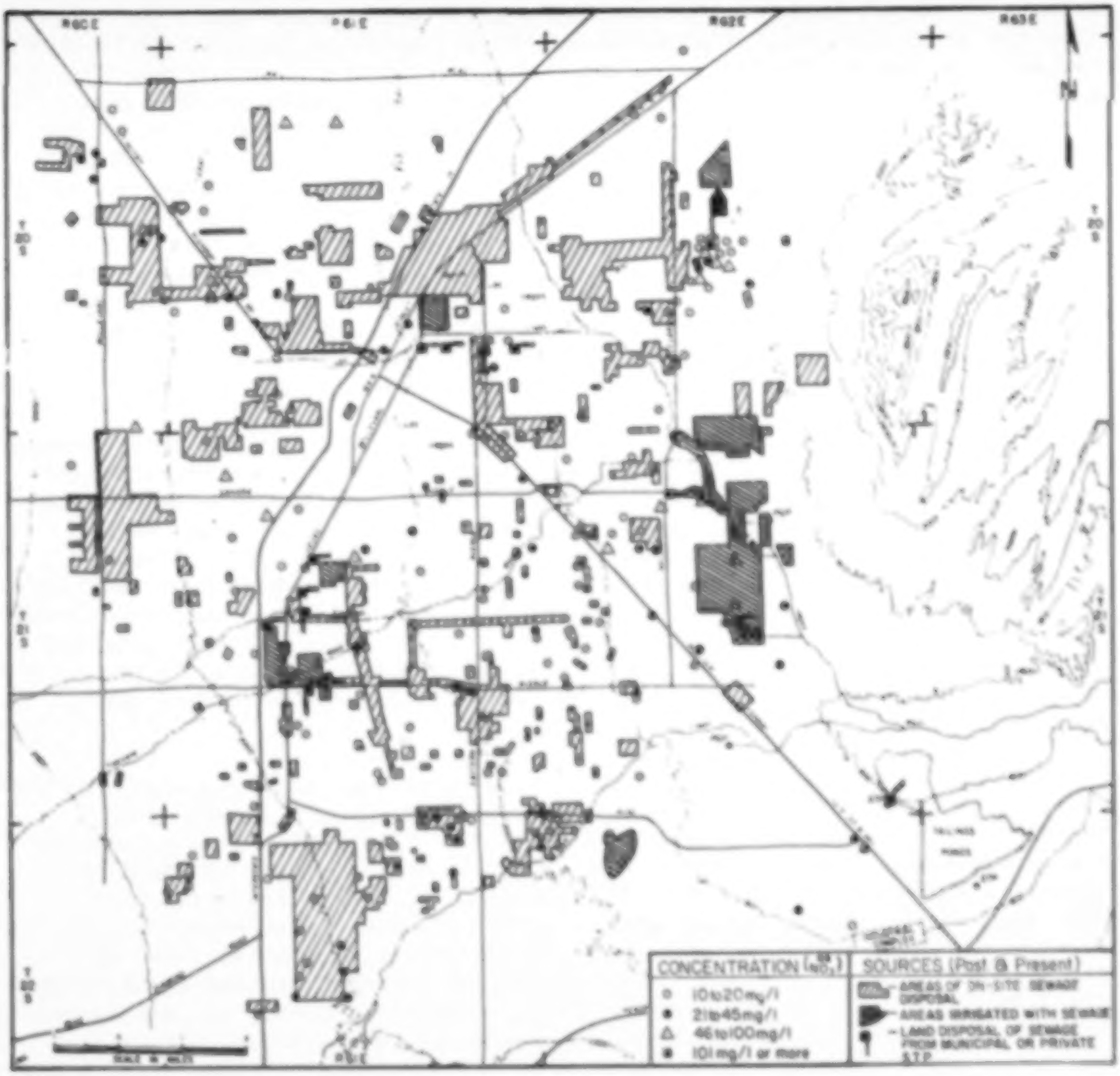

R60E
R61E
R62E
R63E
N
CONCENTRATION
10 to 20 mg/l
21 to 45 mg/l
46 to 100 mg/l
101 mg/l or more
SOURCES (Past & Present)
AREAS OF ON-SITE SEWAGE DISPOSAL
AREAS IRRIGATED WITH SEWAGE
LAND DISPOSAL OF SEWAGE FROM MUNICIPAL OR PRIVATE S.T.P.

Figure 33. Generalized map showing the sources and concentrations of nitrate in ground water.

feet. As a result, emphasis was placed on sampling natural or man-induced springs and seeps and installing wells that just penetrated the water table. The locations of wells and other sampling points considered to tap shallow ground water to depths of 50 feet are shown in Figure 34.

Water quality and head data from domestic wells 100 feet or less in depth in 20/62-21 indicate shallow high quality water moves into this area from the north and west. Contamination of this water by septic tank leachate, leakage from the Nellis Air Force Base sewage treatment plant (20/62-05db), and return flows from the Base golf course which was irrigated with sewage, is evidenced by nitrate concentrations ranging from 10 to 90 mg/ℓ in 11 of the wells 100 feet or less deep and from 10 to 80 mg/ℓ in wells 101 to 300 feet deep (Figure 33). Septic tanks have been in use in this area since the early 1950's. The Nellis treatment plant was active from 1940 to mid-1971 and treated an average of 0.55 million gallons per day (MGD) from 1958 to 1971. The impact of return flows from an oxidation lagoon providing primary treatment for approximately 50,000 gallons a day (gals/day) of sewage from Lake Mead Base, about a mile northeast of Nellis Air Force Base, is unknown. Another closer source of nitrate is return flow from the leachfield of the Meikle Manor trailer court (20/62-12a) which was established in 1958.

High concentrations of nitrate are common in shallow ground water beneath areas irrigated with or receiving sewage. These include the Winterwood and Paradise Valley Golf Courses, the alfalfa fields in the vicinity of the City and County Sewage Treatment Plants, and the underflow of Las Vegas Wash beginning in the reach where sewage return flows first appear. Values of nitrate beneath such areas are variable, with averages ranging from about 40 to 80 mg/ℓ nitrate, several times greater than typical values associated with domestic wells in areas of septic tanks. For this reason, nitrate polluted ground water downgradient from Nellis Air Force Base is believed to be primarily a result of return flow from the Base sewage treatment plant rather than from septic tanks.

Nitrate data summarized in Table 5 show that, with few exceptions, concentrations of 10 mg/ℓ or more in very shallow ground water are present only at sampling points within or closely proximal to a recognizable source, usually sewage effluent. This is particularly true for the LW series of sampling points (springs and seeps). This association is not true for wells LG098, 100, 106, and 110 where low nitrate is present in areas with septic tanks. Conversely, wells LG109 and 109 are in areas without septic tanks but have nitrate well above background. Infiltration of nitrate enriched runoff from fertilized lawns may be the source. Other sources of nitrate include direct recharge by industrial waste (LG031) or sewage effluent (LG034, 037, 060) and return flows area areas irrigated with sewage effluent (LG099, 129, LW015).

Patterns of TDS distribution in ground water at depths of 51 to 100 feet (the eastern portion of which is shown in Figure 35) and 101 to 300 feet (Figure 21) reflect gradual enrichment eastward across the Valley and rapid increase in the vicinity of Las Vegas Wash. This is believed to demonstrate mainly natural influences on water quality. In contrast, both the hand-contoured (Figure 36) and trend surface maps (Figure 37) for TDS in the interval from 0 to 50 feet indicate large differences in terms of absolute

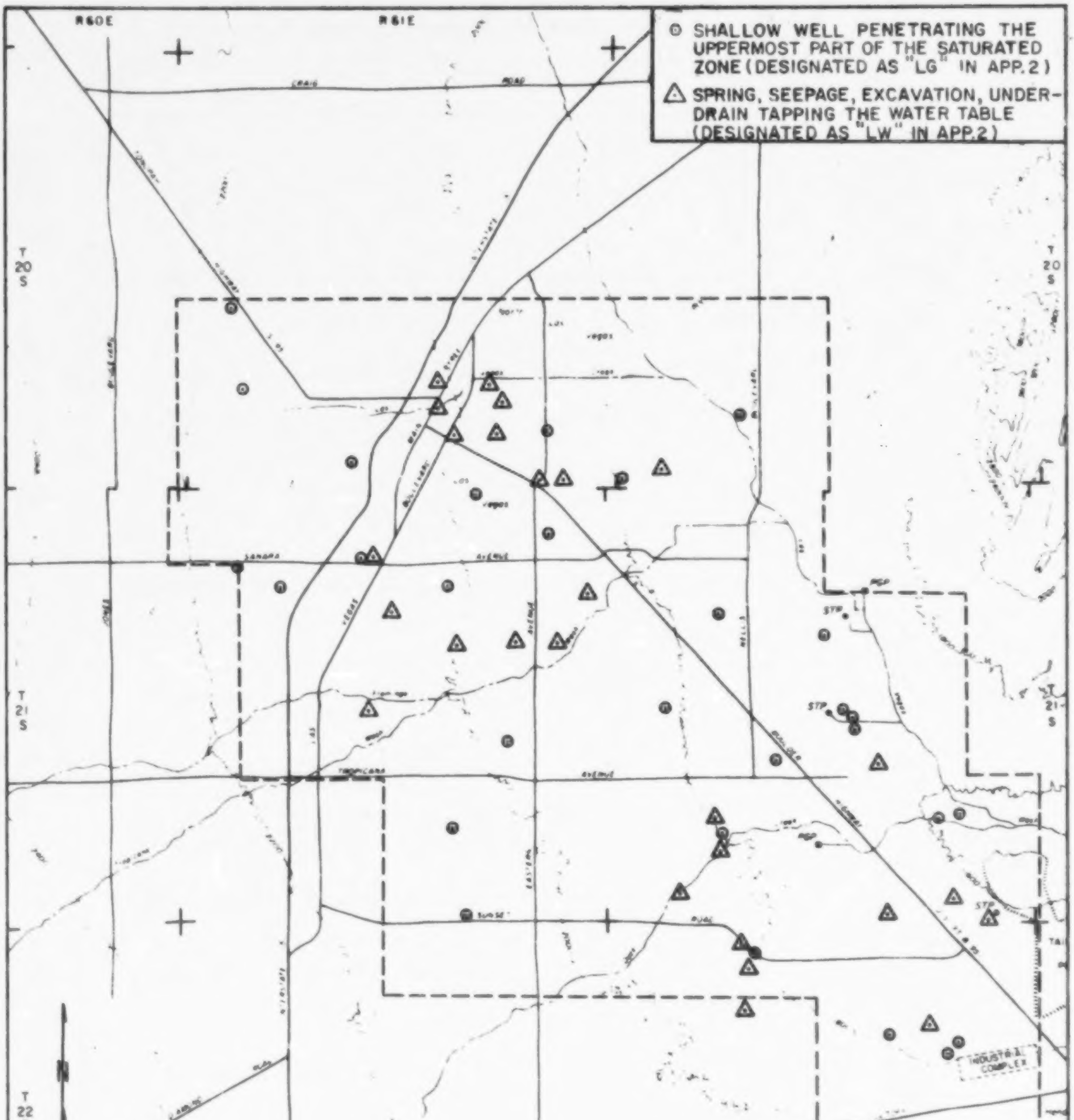

⊙ SHALLOW WELL PENETRATING THE UPPERMOST PART OF THE SATURATED ZONE (DESIGNATED AS "LG" IN APP. 2)
△ SPRING, SEEPAGE, EXCAVATION, UNDERDRAIN TAPPING THE WATER TABLE (DESIGNATED AS "LW" IN APP. 2)
R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
CRAIG ROAD
SAHARA AVENUE
TROPICANA AVENUE
SUNSET
STP
INDUSTRIAL COMPLEX
SCALE IN MILES
N

Figure 34. Locations of wells and springs used to characterize ground-water quality at depths of 0 to 50 feet.

TABLE 5. NITRATE CONCENTRATIONS IN SELECTED GROUND-WATER SAMPLES AS RELATED TO NEARBY LAND USE

Sampling Point	Nitrate mg/ℓ NO_3*	Nearby Source†	Remarks
LW 10	(<0.5)	no	
LW 11	(<0.90)	no	
LW 12	(2.1)	no	
LW 13	(<6.99)	no	
LW 14	(<1.47)	no	
LW 15	(17.8)	Paradise Valley Country Club	Golf course irrigated by sewage effluent
LW 19	(<1.17)	no	
LW 20	(<0.6)	no	
LW 31	(<5.01)	possibly	Lawn runoff and possibly some septic tanks
LW 33	(27.0)	possibly	Discharge from tile drain; area to west may have been irrigated with sewage in past
LW 39	(<0.6)	no	
LW 54	<1.26)	no	
LW 60	<1.19)	no	
LW 72	(3.0)	no	
LW 84	3.3	no	Discharge from spring or tile underdrain
LW 85	8.9	no	
LW 86	9.1	no	
LW 87	13.3	yes	Septic tanks present in area since 1950
LW 88	12.3	yes	Underdrain discharge, inflow partially from area with septic tanks
LW 89	<0.1	no	
LW 90	29.3	yes	Underdrain discharge; inflow from golf course and grassed areas
LW 91	3.4	no	Underdrain discharge; high nitrate expected from a nearby golf course, formerly irrigated with sewage
LW 92	<0.1	no	
LW 94	18.6	yes	Underdrain discharge; nitrate source is unknown
LW 96	(13.2)	yes	Lawn runoff and septic tank leachate
LW 99	12.7	yes	Septic tanks present in the area since 1958
LW100	0.2	no	
LG 30	(1.54)	no	
LG 31	(32.9)	yes	Local recharge by industrial effluent containing nitrate
LG 32	(<1.44)	yes	"
LG 34	(38.6)	yes	Recharged by sewage effluent in Las Vegas Wash
LG 37	(65.3)	yes	Return flow from irrigation with sewage effluent
LG 39	(<0.46)	no	
LG 41	(<0.50)	no	
LG 43	(<0.54)	no	

TABLE 5 (continued)

Sampling Point	Nitrate mg/ℓ NO_3*	Nearby Source†	Remarks
LG 46	(<0.37)	no	
LG 48	(<0.19)	no	
LG 60	(87.6)	yes	Sewage effluent from Clark County STP
LG 98	(0.9)	yes	Background nitrate concentration in return flow despite nearby septic tanks and livestock; three other local wells contain from 17 to 35 mg/ℓ
LG 99	(83.2)	yes	Irrigation return flow; sewage effluent
LG100	(2.1)	yes	Background concentrations are unexpected insofar as the adjacent area contains septic tanks since the 1950's
LG101	(6.6)	possibly	Occasional high nitrate may be irrigation return flow from lawns in the nearby residential development
LG102	(0.57)	no	
LG103	(5.97)	no	
LG104	(93.5)	yes	Rapid increase between April and September may be result of nitrogen fertilizer in runoff from a nearby golf course
LG105	(0.47)	no	
LG106	(0.95)	yes	Background nitrate concentration is present in the return flow despite nearby septic tanks in use since the 1950's; 8 local wells contain 10 to 38 mg/ℓ NO_3
LG107	(1.17)	no	
LG108	(61.7)	possibly	Source of high nitrate is possibly runoff from lawns in nearby development; recent recharge is indicated by a concentration of 16.4 TU in shallow water table
LG109	(43.2)	possibly	Same comments as above; no tritium data collected
LG110	(1.52)	yes	Area contained septic tanks since the early 1940's and shallow ground water has 16.3 TU indicating some recent recharge; lack of nitrate unexplained
LG128	91.0	yes	Return flow from an area irrigated with sewage effluent
LG129	9.3	no	
LG138	40.0	possibly	Sample collected from very shallow water table downgradient from International Hotel golf course
LG139	52.0	yes	Septic tanks

* The values shown are from one-time grab samples except for averaged data shown in parentheses. All chemical data are from Appendix 3.

† Land use patterns summarized by Patt (1977) were examined to determine if a source of nitrate could be identified in the immediate area (of the well or spring) or in the area hydraulically upgradient therefrom.

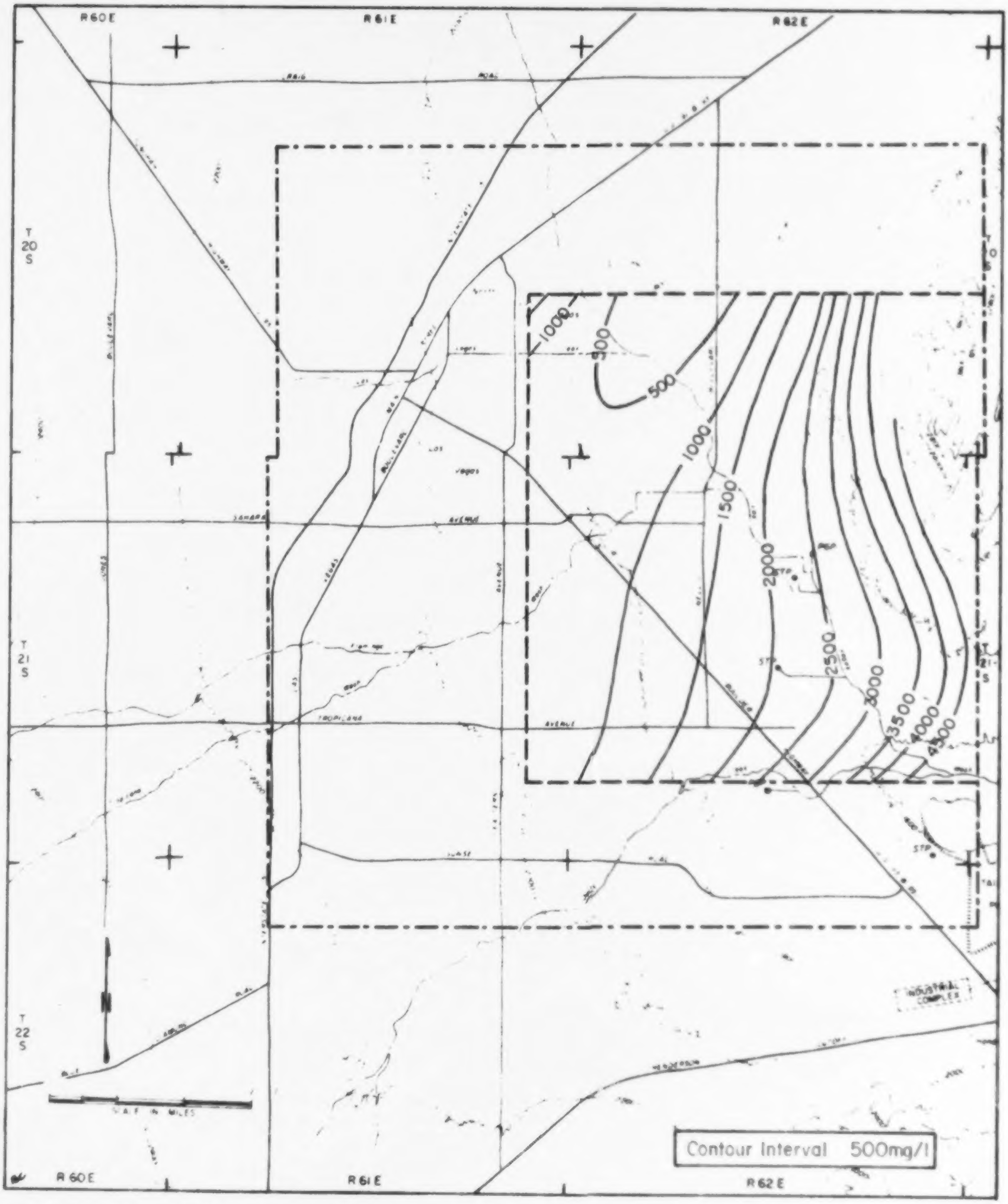

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
1000
500
500
1000
1500
2000
2500
3000
3500
4000
4500
STP
INDUSTRIAL COMPLEX
SCALE IN MILES
R 60 E
R61E
R62E
Contour Interval 500mg/l

Figure 35. Fifth degree trend surface for total dissolved solids in ground water at depths of 51 to 100 feet.

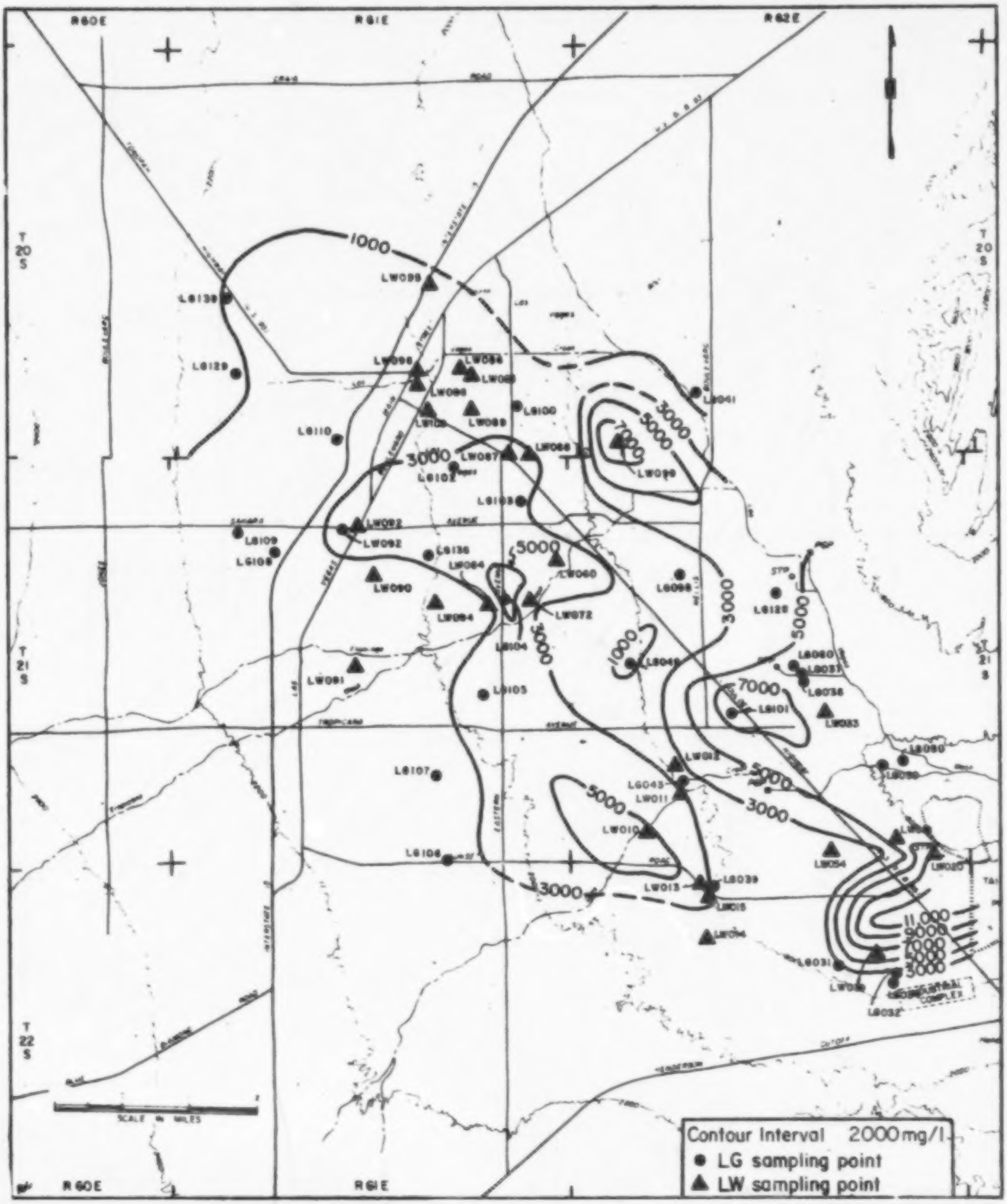

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
1000
3000
5000
7000
11,000
9000
LW099
LG139
LG129
LG110
LW096
LW084
LW086
LW089
LG100
LW087
LW088
LG102
LG103
LW092
LG109
LG108
LG136
LW090
LW094
LW060
LW072
LG104
LG098
LG128
LW091
LG105
LG049
LG101
LW083
LG107
LW012
LG043
LW011
LW010
LG106
LW013
LG039
LW015
LW014
LW054
LW020
LG031
LG032
LW041
LW080
SCALE IN MILES
Contour Interval 2000 mg/l
● LG sampling point
▲ LW sampling point

Figure 36. Distribution of total dissolved solids in ground water at depths of 0 to 50 feet (manually contoured).

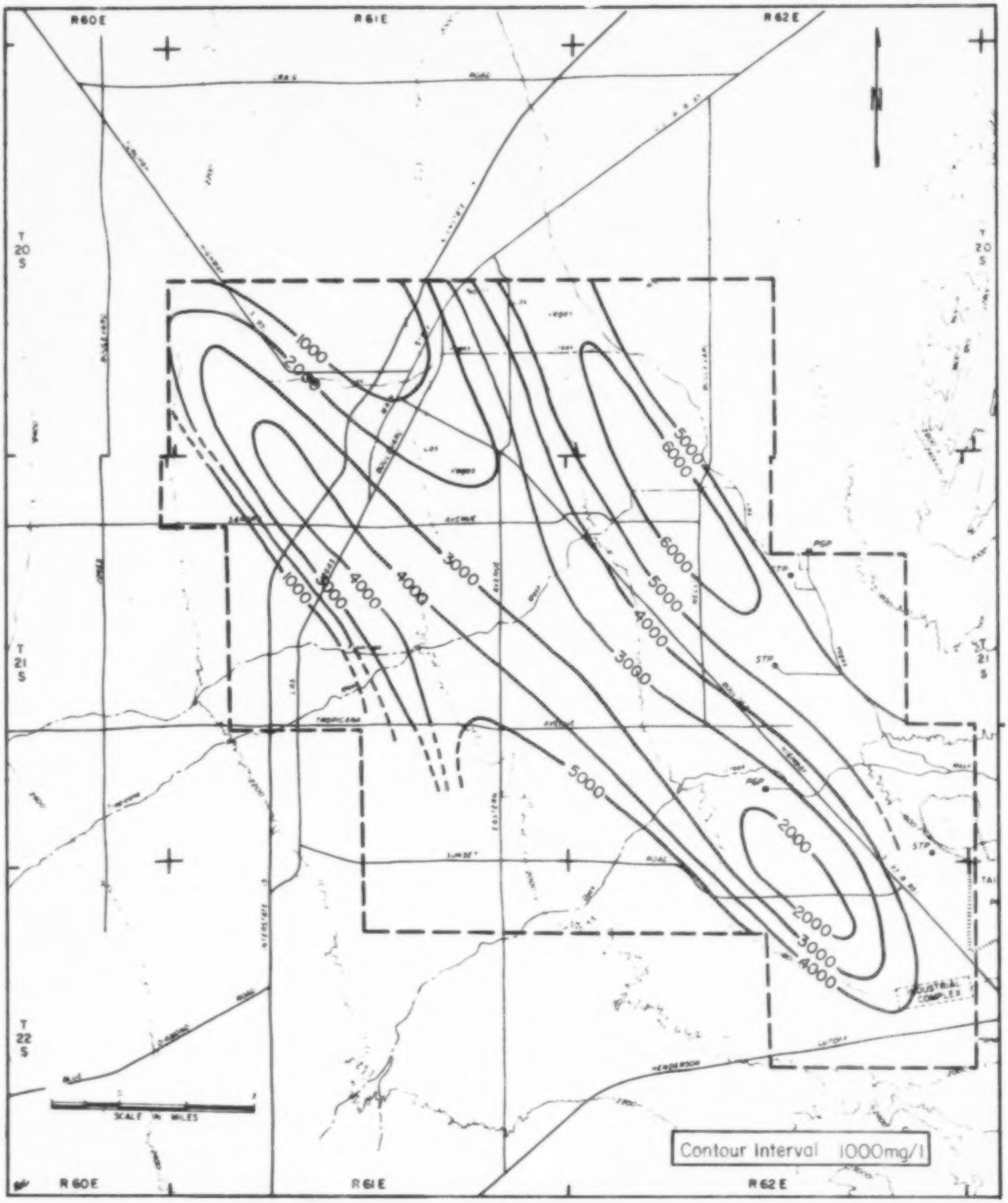

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
1000
2000
3000
4000
5000
6000
STP
PGP
INDUSTRIAL COMPLEX
SCALE IN MILES
Contour Interval 1000mg/l

Figure 37. Sixth degree trend surface for total dissolved solids in ground water at depths of 0 to 50 feet.

concentrations and pattern or regularity. The trend surface shows that mineralized waters occur near parallel, northwest trending highs located across 1) Paradise Valley, the Las Vegas Strip and the BMI complex, and 2) the northeastern portions of the urbanized area. In the western, northern, and northeastern portions of the study area, about 1,000 mg/ℓ TDS may constitute the ambient condition. Increasing mineralization along the flow path is evident as TDS reaches 3,000 mg/ℓ within a few miles. This increase is, in part, a result of natural factors, including the presence of mineralized soils and concentrating effects of evapotranspiration. Human influence may be indicated by peak concentrations of TDS which occur in patterns roughly coincidental with previous sewage disposal in the area of the Las Vegas Strip, in part of the upper reach of Las Vegas Wash in the vicinity of old and recent sewage disposal areas or areas irrigated with sewage, and in the southeastern part of the Valley near the BMI complex. Return flows from nonpoint urban and suburban sources solubilize salts formerly deposited in the shallow soil profile by discharging ground water. The magnitude of change in water quality is poorly defined but is expected to be sizeable, particularly in the eastern third of the Valley where saline soils are highly developed and where ground-water levels are closest to the land surface. Presence of sanitary wastes in shallow ground water is already indicated by chloride and nitrate, in particular.

Chloride at depths of 0 to 50 feet (Figure 38) increases in concentration from about fifty mg/ℓ northwest of the urban area to between 500 and 1,000 mg/ℓ in the upper reaches of Las Vegas Wash. Concentrations at stations LW019, LW020, LG031, and LG050 are noticeably higher than the regional trend due to the presence of industrial wastewater return flows in the shallow aquifer. From 1971 through 1973, waste discharges from the BMI complex exhibited a wide range in chloride concentrations (178 to 168,310 mg/ℓ). An average value is difficult to define but is probably at least 5,000 mg/ℓ and, therefore, well above background. This influences the concentration gradients for chloride in the very shallow aquifer in the southeastern part of the Valley.

UTILITY OF THE TREND SURFACE TECHNIQUE

Trend surfaces and statistics for various depth intervals proved useful for evaluating and portraying lateral ground-water quality variations and the degree of variability. Judgements are made in rejecting anomalous raw data and in comparing plots of raw data to determine what order surface provides the "best fit." Effects of such judgements were apparent, as evidenced by the increased value of the correlation coefficient derived from selected versus raw data (Table 6). Nevertheless, if there was poor initial correlation (in the case of magnesium, chloride and nitrate for the interval from 101 to 300 feet) little change was effected in the coefficient following the data selection procedure.

The highest correlation coefficient was generally associated with the sixth order surface, but only in a few instances was this surface judged the best indicator of overall trends. This decision was made on the basis of visual comparison of various surfaces with plots of the actual data. Absolute values of the coefficients were indicative of the order or trend, or lack thereof, in the data.

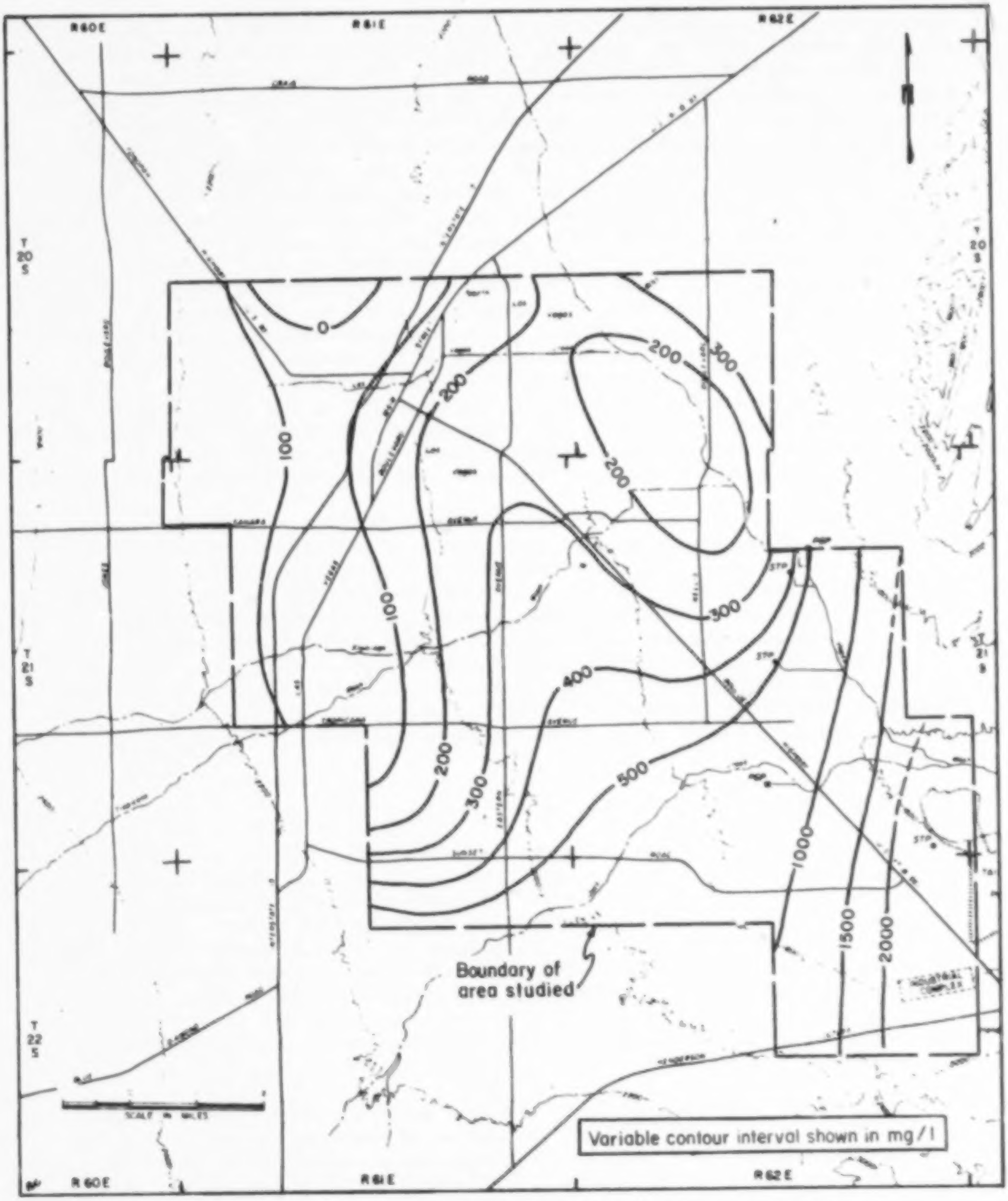

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
0
100
100
200
200
200
200
300
300
300
400
500
1000
1500
2000
Boundary of area studied
SCALE IN MILES
Variable contour interval shown in mg/l
R60E
R61E
R62E

Figure 38. Fourth degree trend surface for chloride in ground water at depths of 0 to 50 feet.

TABLE 6. SUMMARY OF CORRELATION COEFFICIENTS FOR THE TREND SURFACES

Depth (feet)		Surface			Parameter			
From	To	Order	Ca	Mg	SO_4	Cl	NO_3	TDS
0	50	1			.285	.531	.049	.516
					(.302)	(.705)	(.032)	(.538)
		2			.424	.650	.158	.536
					(.510)	(.834)	(.424)	(.604)
		3			.506	.687	.468	.601
					(.525)	(.886)	(.552)	(.618)
		4			.558	.707	.684	.625
					(.500)	(.909)	(.697)	(.608)
		5			.517	.698	.686	.619
					(.510)	(.904)	(.696)	(.602)
		6			.599	.688	.683	.611
					(.581)	(.932)	(.704)	(.665)
51	100	1	.432	.306	.469	.451	.134	.486
		2	.672	.511	.687	.711	.249	.737
		3	.694	.547	.709	.829	.441	.769
		4	.741	.660	.755	.857	.500	.785
		5	.743	.668	.760	.882	.627	.798
		6	.744	.674	.763	.905	.651	.805
101	300	1	.466	.294	.427	.375	.022	.424
			(.530)	(.365)	(.513)	(.377)	(.128)	(.500)
		2	.516	.367	.498	.434	.096	.483
			(.589)	(.425)	(.587)	(.440)	(.252)	(.582)
		3	.554	.409	.530	.452	.185	.499
			(.626)	(.481)	(.635)	(.468)	(.355)	(.619)
		4	.581	.427	.548	.466	.232	.518
			(.669)	(.521)	(.673)	(.477)	(.437)	(.656)
		5	.593	.429	.553	.480	.235	.524
			(.587)	(.486)	(.583)	(.474)	(.201)	(.628)
		6	.586	.320	.465	.327	.142	.346
			(.671)	(.502)	(.657)	(.039)	(.246)	(.670)

Note: Numbers in parentheses derived after removing anomalous data and using no more than one analysis per location.

Several shortcomings in the use of trend surfaces and their statistics to display ground-water quality variations were apparent. For the present study, at least, there was an inverse relationship between the amount of data and the "goodness of fit" for a given surface and parameter. Similar results were reported by Rockaway and Johnson (1967) in their analysis of water level data. For example, the interval from 0 to 50 feet had fewer data points, generally resulting in a higher correlation coefficient compared to the intervals from 51 to 100 and 101 to 300 feet. This erroneously indicated there was greater regularity or order in the very shallow system when in fact the opposite was true.

High data values for nitrate and chloride at depths of 0 to 50 feet were consistently associated with sanitary and industrial wastes in the eastern part of the Valley. Away from areas of waste disposal and for most samples collected below a depth of 50 feet, nitrate is 5 mg/ℓ or less and this is considered background. Where well depths exceeded 50 feet or were unknown, the chemical data were not used in the trend surface portrayals for the interval 0 to 50 feet. The combination of few data points and the association of high nitrate in areas of waste disposal, therefore, partially accounted for the high (0.704) correlation coefficient for the interval from 0 to 50 feet versus only 0.246 for the interval from 101 to 300 feet. The low coefficient of correlation for nitrate at depths of 101 to 300 feet suggests very little variation, i.e., background conditions, whereas in the shallow aquifer there is obviously a high positive correlation that can be attributed to urbanization.

Another weakness clearly demonstrated by some of the trend surfaces was that the best fit to the available data frequently had unrealistic values in marginal areas where data were scarce or nonexistent. This even resulted in negative values (see examples, Figure 31 and 32), which indicated failure of the surface to "fit" the actual data. Perhaps a final problem of using the technique was the tendency for misunderstanding the difference between a trend surface and maps or surfaces manually contoured from real data. Whereas both approaches showed concentration increase or decrease, trend surfaces did not always clearly express true values and local deviations.

ANALYSIS OF TEMPORAL CHANGES IN GROUND-WATER QUALITY

Description of Study Method and Data Base

Ground-water quality data from previous studies by Carpenter (1915), Hardman and Miller (1934), Maxey and Jameson (1948), and Malmberg (1965) were supplemented with analyses collected during the study to determine if significant changes had occurred with time. The chemical data, well characteristics, and sampling locations are shown in Appendices 4 and 5, and Figure 39, respectively. An unpublished survey made by L. Reed of the Desert Research Institute to determine chemical stratification in ground water and unpublished work for the Nevada State Engineer by Domenico and Maxey (1964) were also referred to. The latter contained data and conclusions concerning changes in ground-water quality in the period from the early 1940's to 1963. Prior to the present study, this was the only attempt to document temporal change in ground-water quality in the Valley. From comparisons of chemical data from 1942-1944 and 1963, Domenico and Maxey (1964) concluded quality had not

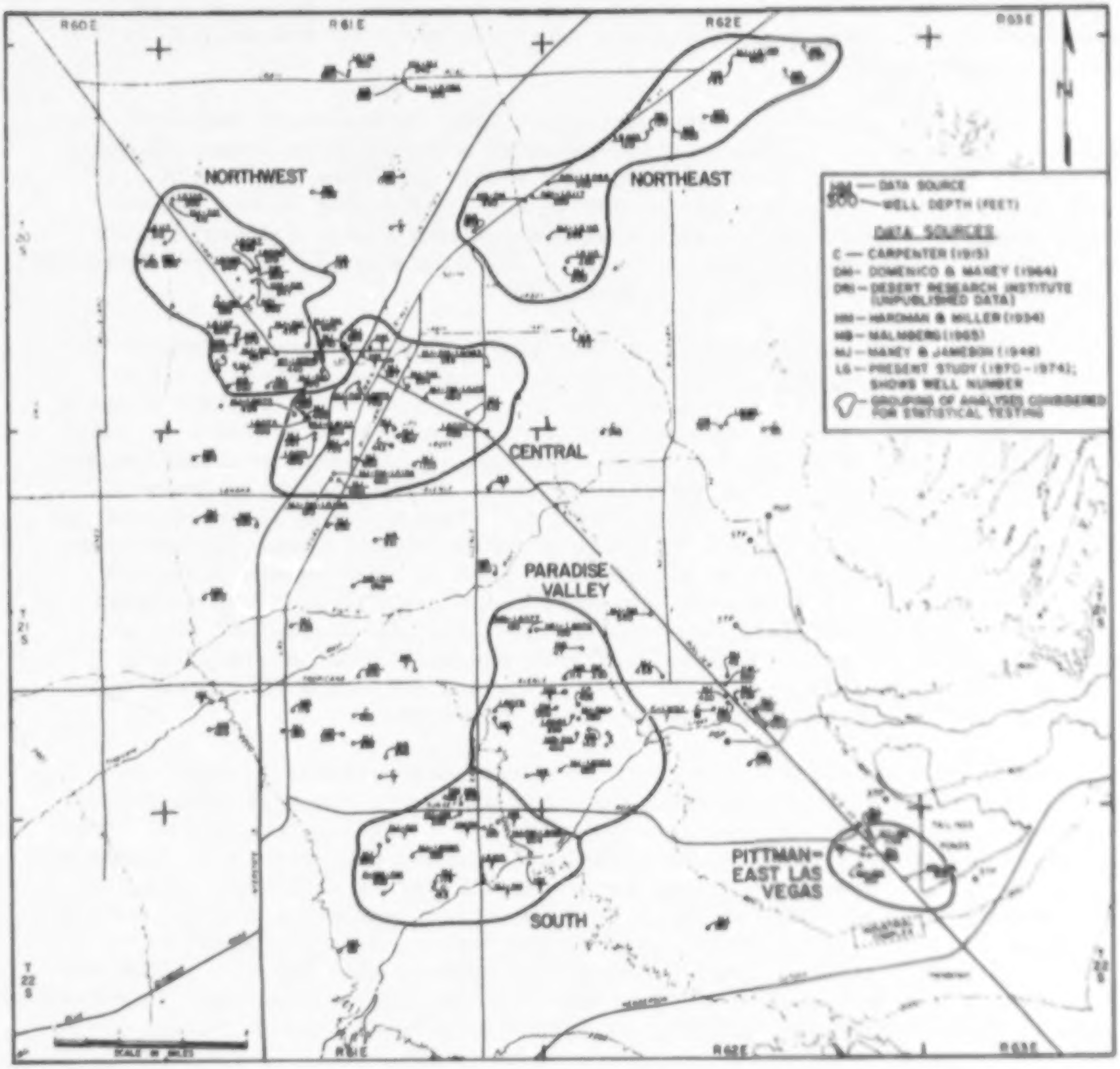

R60E
R61E
R62E
R63E
N
NORTHWEST
NORTHEAST
CENTRAL
PARADISE VALLEY
PITTMAN-EAST LAS VEGAS
SOUTH
T 20 S
T 21 S
T 22 S
500
DATA SOURCE
WELL DEPTH (FEET)
DATA SOURCES
C — CARPENTER (1915)
DM — DOMENICO & MAXEY (1964)
DRI — DESERT RESEARCH INSTITUTE (UNPUBLISHED DATA)
HM — HARDMAN & MILLER (1934)
MB — MALMBERG (1965)
MJ — MAXEY & JAMESON (1948)
LG — PRESENT STUDY (1970-1974); SHOWS WELL NUMBER
GROUPING OF ANALYSES CONSIDERED FOR STATISTICAL TESTING
SCALE IN MILES

Figure 39. Locations of wells sampled between 1915 and 1972.

deteriorated in the areas of major withdrawals but there was evidence of deterioration in the southern and southwestern parts of the Valley.

Beginning in 1962, the District Health Department began an extensive ground-water sampling program to ascertain the quality of public and private potable water supplies in Clark County, with emphasis on Las Vegas Valley. Data from this program, which was most active from 1968-1972, were extremely valuable to the present study in defining spatial variations in water quality attributable to land and water use patterns and natural hydrogeologic conditions.

In contrast, there are few historical data to ascertain temporal changes. Excluding: 1) recent (1969-present) analyses from producing wells in the Las Vegas Valley Water District and North Las Vegas well fields, 2) water quality data collected by the Health Department, and 3) the present study, there are approximately 412 analyses extending over the period 1921-1967. The analyses extend over an area of 150 square miles and were collected from wells ranging from 8 to 1,700 feet deep.

Tables 7 and 8, respectively, summarize the depth intervals sampled for the various townships and periods of sampling for the same areas. Table 7 shows that 44 percent of historical water quality data prior to 1968 pertain to wells of unspecified or unknown depth. Therefore, much of their scientific value is lost. Furthermore, only 2 percent of available analyses document very shallow water quality in the 0 to 100 foot depth interval whereas 22 percent are from wells deeper than 400 feet. The remaining 32 percent of the analyses are from wells ranging in depth from 101 to 400 feet. In townships 21/62 and 22/62, deteriorating ground-water quality from return flows and solution of evaporites from a rising water table are difficult to document because there are essentially no chemical data for the unconfined aquifer. Townships 20/60, 21/60, and 22/60 similarly are devoid of baseline water quality data, hence changes in the system, from a multitude of causes, are and will continue to be extremely difficult to document.

Historical records for all depth intervals are noticeably absent in 20/60, 21/60, and 22/60. The impact of this shortcoming may be substantial considering the rapid urbanization underway in the eastern portions of 20/60 and 21/60. For 20/61, 21/61, and 22/61, data extend over a period of approximately 45 years. However, paucity of analyses makes it difficult to define the chemical state of the system at given points or certain periods. With the exception of 20/61, 21/61, 21/62, and 22/61, nothing is known about historical ground-water quality prior to the 1955 to 1962 period. Since the early 1940's sewage and industrial wastes were deliberately allowed to infiltrate in 20/62, 21/62, and 22/62 with essentially no monitoring data.

A recognized shortcoming of the approach chosen to compare historical trends in water quality was the comparison of wells of greatly varying depths that, in all likelihood, tapped different aquifers. To overcome this, analyses would have to be additionally segregated by well depth thereby further reducing each sample group and, in turn, degrees of freedom.

As stated earlier, previously sampled wells were field located or substitute wells constructed to provide recent chemical data for comparison with

TABLE 7. NUMBER AND DISTRIBUTION OF CHEMICAL ANALYSES OF GROUND WATER FOR THE PERIOD 1912-1967 INCLUSIVE

Township	Total number of analyses 1912-1967	Well Depth Range (in feet)											
		Unknown		0-100		101-200		201-300		301-400		401+	
		#	%	#	%	#	%	#	%	#	%	#	%
20/60	12	5	41	0	0	3	25	1	8	2	16	1	8
20/61	61	14	23	0	0	0	0	0	0	14	23	33	54
20/62	67	27	40	6	9	16	24	9	13	2	3	7	10
21/60	9	3	33	0	0	0	0	5	55	0		1	10
21/61	124	61	49	2	2	10	8	13	10	9	7	29	23
21/62	40	20	41	0	0	9	18	1	2	6	12	13	27
22/60	NO CHEMICAL DATA COLLECTED PRIOR TO 1968												
22/61	68	39	57	1	1	16	15	9	13	5	7	4	5
22/62	22	12	55	0	0	5	23	3	14	0	0	2	9
TOTAL	412	181	44	9	2	53	13	41	10	38	9	90	22

TABLE 8. YEAR AND LOCATION OF CHEMICAL ANALYSES OF GROUND WATER FOR THE PERIOD 1912-1967 INCLUSIVE

	Township								
Year	20/60	20/61	20/62	21/60	21/61	21/62	22/60	22/61	22/62
1912	1	2			1	2		3	
1926								1	
1927		1			2				
1929						1			
1930					3			1	
1931		3							
1932		2							
1934		2			1				
1935					1				
1938		1							
1941		3	1		2			1	
1942		1				14		2	1
1943					1				
1944		6			3			3	
1945		9	3		6	1		2	3
1946						2			
1947		3			9	4			
1951		1							
1952		1							
1953					1				
1955			1						
1956		3	4						
1957						2			
1962	2	11	5	3	18	1		9	5
1963		6	7		20	6		14	2
1964		2	7		10	1		10	1
1965	2	3	3	2	9	3		4	
1966	1	6	10	2	19	1		9	6
1967	5	4	24	1	15	9		9	3
Sub-Total	11	70	65	8	121	48		68	22
TOTAL	412								

historical analyses. Pertinent data concerning both the original and substitute wells are shown in Appendix 5. There are inconsistencies in determining and reporting TDS concentrations in previous studies. This parameter was recalculated and presented as the sum of the principal ionic constituents, with bicarbonate expressed as carbonate, following the conversion specified in Hem (1970). Table 9 summarizes how TDS was determined in previous studies and how the original data are presented in Appendix 4. For consistency all historical and recent data in this report show TDS calculated by summation, with bicarbonate converted to carbonate.

TABLE 9. METHODS USED TO DETERMINE TOTAL DISSOLVED SOLIDS IN PREVIOUS STUDIES

Reference	Original determination	Original value presented in Appendix 4 under heading:
Carpenter, 1915	Residue on evaporation	Evaporation
Hardman and Miller, 1934	Residue on evaporation	Evaporation
Maxey and Jameson, 1948	Summation of dissolved constituents without conversion of bicarbonate to carbonate	Total
Desert Research Institute, 1963 (unpublished data)	Summation of dissolved constituents without conversion of bicarbonate to carbonate	Total
Domenico and Maxey, 1964	Residue on evaporation	Evaporation
Malmberg, 1965	1. Analyses by U.S. Geological Survey reported residue upon evaporation at 180°C	Evaporation
	2. Analyses by University of Nevada, Reno calculated total dissolved solids from specific conductance and as residue upon evaporation	Total

Groupings of wells in various parts of the Valley for which historical chemical data are available are shown in Figure 39. Groups were selected using criteria of: 1) generally similar hydrogeologic and water quality conditions within each area; 2) sufficient number of wells to constitute a minimal sample size for statistical tests; and 3) different time periods in which changes in water quality could be compared.

Within each areal grouping of historical ground-water quality data, the values for TDS and chloride were analyzed for temporal change by means of two nonparametric tests, the Mann-Whitney test and, in cases where sufficient data were present, the Kruskal-Wallis test for one-way analysis of variance. Nonparametric statistical techniques were chosen because of uncertainty concerning the normality of the sample distribution, the sample size, and the fact that data were not on interval or ratio scale. Detailed explanation of the tests and their application to hydrogeological problems are found in Siegel (1956) and Siddiqui and Parizek (1972), respectively.

The Mann-Whitney test was used to evaluate whether two independent samples of chemical data from the same general area of the Valley, but from different time periods, belonged to the same population. A two-tailed test at the five percent level of significance was specified and compared to the probability associated with the test statistic, U or z. The raw chemical data are arranged in ascending order, assigned ranks and then the latter are grouped according to year to calculate the statistic U using either of the following:

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1$$

or

$$U = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2$$

where R_1 = sum of the ranks assigned to the group with sample size n_1

R_2 = sum of the ranks assigned to the group with sample size n_2

Depending on the values for n_1 and n_2, either critical values of U or probabilities associated with the observed U are used to accept or reject the null hypothesis at the preset level for α. If the larger group (n_2) exceeds 20, U is calculated as shown and then used to determine z:

$$z = \frac{U - (n_1 n_2)/2}{\sqrt{\frac{(n_1)(n_2)(n_1 + n_2 + 1)}{12}}}$$

which is almost normally distributed with zero mean and unit variance (Siegel, 1956). Tabular values of probability associated with the observed value of z are compared with the previously set level of significance ($\alpha = 0.05$) to accept or reject the null hypothesis.

The Kruskal-Wallis one-way analysis of variance by ranks, tests whether k independent samples are from the same population. As in the case of the Mann-Whitney test, the null hypothesis states the k samples are from the same population. That is, the differences among samples are either genuine population differences or they are chance variations likely to occur among random samples. In the Kruskal-Wallis test, three or more groups of data are tested, whereas the Mann-Whitney test compares two groups at a time.

The H statistic used in the Kruskal-Wallis test is defined as follows:

$$H = \frac{12}{N(N + 1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N + 1)$$

where R = number of samples

n_j = number of cases in the jth sample

$N = \sum n_j$; the total number of observations

j = sum of ranks in jth sample (column)

$\sum_{j=1}^{k}$ = sum over the k samples (columns)

Where the k samples are from the same population or identical populations, H_o is true. H is distributed as Chi square (χ^2) with N-1 degrees of freedom (df).

Significance of Test Results

Initial results of the Mann-Whitney test are presented in Table 10 for each subarea of the Valley containing sufficient analyses for comparison purposes. Values for TDS and chloride from previous studies were compared to see if statistically significant changes occurred between each time period. For the time periods and depths considered (range 8 to 1,700 feet; mean 468 feet, standard deviation 262 feet), essentially no significant change in ground-water quality from 1912 to present is shown to have occured anywhere in the Valley. At first glance this may demonstrate the slowness with which a large, heavily developed ground-water reservoir exhibits change in water quality due to a variety of stresses. It is the author's contention that insufficient data exist to depict change and that the tests, in fact, are not diagnostic.

In a second attempt to test the data and to reduce the shortcomings inherent in statistical testing with a sparse data base, larger sample sizes were generated for the six subareas by grouping and comparing the available chemical data for the periods 1912 to 1945 and 1962 to 1972. This grouping is hydrologically justified in the northwest and central areas. Although the period prior to 1946 was characterized by gradually increasing ground-water withdrawal, overdraft did not occur (Maxey and Jameson, 1948). Recharge to the deeper, artesian aquifers was believed to be primarily by lateral inflow without significant vertical leakage from the shallow aquifer. Similarly, chemical data for the period 1962 to 1972 represents different hydrologic conditions in that overdraft conditions are believed to have prevailed since 1946 and significantly since 1962, when 55,500 acre feet of water were pumped. Peak pumpage of 70,000 acre feet occurred in 1973. Since 1971 there has been a gradual decline in ground-water withdrawal by the Las Vegas Valley Water District because Lake Mead water became more widely available with completion of Stage I of the Southern Nevada Water Project.

TABLE 10. SUMMARY OF THE MANN-WHITNEY TEST RESULTS TO EVALUATE HISTORICAL CHANGES IN GROUND-WATER QUALITY

Area: NORTHWEST

Sampling Date	1912	1934	1942	1947	1962	1968	1972
1912			NS S		NS S		NS S
1934			NS NS	NS NS	NS NS		NS NS
1942				NS NS	NS NS		NS NS
1947							NS NS
1962						NS NS	NS NS
1968							NS NS

Area: CENTRAL

1912			NS NS				
1934			NS NS		NS NS		S NS
1942					NS NS		NS NS
1947							
1962							NS NS
1968							

Area: PARADISE VALLEY

1912		NS NS	NS NS		NS NS		NS NS
1934					NS NS		NS NS
1942					NS NS		NS NS
1947							
1962							NS NS
1968							

Area: SOUTH

Sampling Date	1912	1934	1942	1947	1962	1968	1972
1912			NS NS	NS NS	NS NS		NS NS
1934				NS NS			NS NS
1942				NS NS			NS NS
1947						NS NS	NS NS
1962						NS NS	NS NS
1968							NS NS

Area: NORTHEAST

1912							
1934							
1942				NS NS	NS NS	NS NS	NS NS
1947					NS NS	NS NS	NS NS
1962						NS NS	NS NS
1968							NS S

Area: PITTMAN-EAST LAS VEGAS

1912							
1934							
1942				NS NS	NS NS		
1947					NS NS		
1962							
1968							

Notations "NS" and "S" indicate not significant or significant, respectively, and refer to observations for the paired year groups considered. Blanks indicate no data or insufficient data for test. Values in the upper left and lower right of each box refer to TDS and chloride, respectively.

Results of testing for various subareas delineated in Figure 39 are shown in Table 11. Significant change in TDS and chloride has occurred in the northwest area. Deteriorating water quality through time is indicated by increased mean values of 118 and 21.2 mg/ℓ for TDS and chloride, respectively. In the central area, significant change did not occur. Despite the absence of statistically significant change, TDS and chloride increased 83 and 11.6 mg/ℓ, respectively. The central area has not been the locus of heavy pumping because high yield wells are uncommon and water quality is less satisfactory than in the main well fields to the west and northwest. Changes in groundwater quality may be a result of induced lateral or vertical influx of poorer quality water.

TABLE 11. RESULTS OF THE MANN-WHITNEY TEST TO DETERMINE SIGNIFICANT CHANGE IN GROUND-WATER QUALITY FOR THE PERIODS 1912-1945 AND 1962-1972

Area	Parameter	1912-1945 # samples	1962-1972 # samples	Statistic values U_c	U_t	Z_c	Z_t	Result*
Northwest	TDS	17	19	77	99			S
	Cl	17	19	83	99			S
Central	TDS	24	16			1.19	1.28	NS
	Cl	24	16			0.36	1.28	NS
Paradise Valley	TDS	16	9	58	37			NS
	Cl	16	9	57	37			NS
South	TDS	8	12	47	22			NS
	Cl	8	12	42	22			NS
Northeast	TDS	3	10	12	3			NS
	Cl	3	10	2	3			S
Pittman-East Las Vegas	TDS	5	3	5	0.572			NS
	Cl	5	3	7	1			NS

* S = Significant; NS = Not Significant; α 0.05.

With the exception of chloride in the northeast area, analyses from the remaining four areas (Paradise Valley, south, northeast and Pittman-East Las Vegas) showed no significant change in water quality. Considering the small sample sizes for the northeast, the change in chloride may simply be coincidental.

The general lack of significant change compared to constituent increases in the northwest and central areas suggests only minor hydraulic response of the shallow aquifers as a result of local and valley-wide water use patterns through time. In general, the long term trend in the other four areas cited has involved reduction of artesian head due to overdraft elsewhere in the Valley. Typically, development of single family domestic ground-water supplies has been the rule, although in the past there was irrigated agriculture in Paradise Valley involving both flowing and pumped wells (Maxey and Jameson, 1948). In the vicinity of East Las Vegas, a slight increase in artesian pressure was observed in the period 1952 to 1964 (Domenico, et al., 1964). Marked changes in head and reversals of flow gradients between confined and water table aquifers, as is the case in the western part of the Valley, are not evident. Rather, the greatest hydraulic and water quality responses are due to increased irrigation return flow and infiltration of sanitary and industrial waste representing additions to shallow ground-water storage (Kaufmann, 1971; Westphal and Nork, 1972). An adequate number of shallow sampling points does not exist to monitor expected changes over time.

Table 12 summarizes Kruskal-Wallis test results for TDS and chloride concentrations in selected areas (see Figure 39). The probabilities shown in column 5 are tabular values (Siegel, 1956) associated with the observed value of H for two degrees of freedom. In all cases the observed values of H with two degrees of freedom have a probability of occurrence greater than the preset level of significance(α) of 0.05. Therefore, the result was to accept the null hypothesis that samples are from the same population, i.e., no significant change in ground-water quality has occurred.

TABLE 12. RESULTS OF THE KRUSKALL-WALLIS TEST TO DETERMINE SIGNIFICANT CHANGE IN GROUND-WATER QUALITY FOR PERIOD 1944-1972

Area	Years Considered	Parameter	H Statistic	Probability associated with H	Result*
Northwest	1944-1963-1972	TDS	5.46	~ 0.069	NS
		Cl	3.446	$.10 < p < .20$	NS
Central	1944-1963-1972	TDS	3.14	$.2 < p < .30$	NS
		Cl	1.79	$.3 < p < .5$	NS
South	1956-1963-1972†	TDS	2.14	$.129 < p$	NS
		Cl	3.00	$.129 < p$	NS
Paradise Valley	1944-1963-1972†	TDS	1.01	$.105 < p$	NS
		Cl	3.17	$.105 < p$	NS
Pittman-E. Las Vegas	1944-1963-1972†	TDS	0.66	$.123 < p$	NS
		Cl	1.06	$.123 < p$	NS

* NS = Not Significant; $\alpha = 0.05$; df =2.

† Considering only wells less than 300 feet or less in depth.

UTILITY OF THE DATA STORAGE AND RETRIEVAL SYSTEM

Two examples of the versatility of the water quality data storage and retrieval system developed to meet study objectives are described below. To determine where ground-water quality in the depth interval from 101 to 300 feet does not meet the U. S. Public Health Service (1962) drinking water standards for sulfate (250 mg/ℓ) and TDS (1,000 mg/ℓ), a plot (Figure 40) was prepared which shows the location of the wells and the parameters involved. An arbitrary limit of 500 mg/ℓ for hardness was set on the basis of comments in McKee and Wolf (1973).

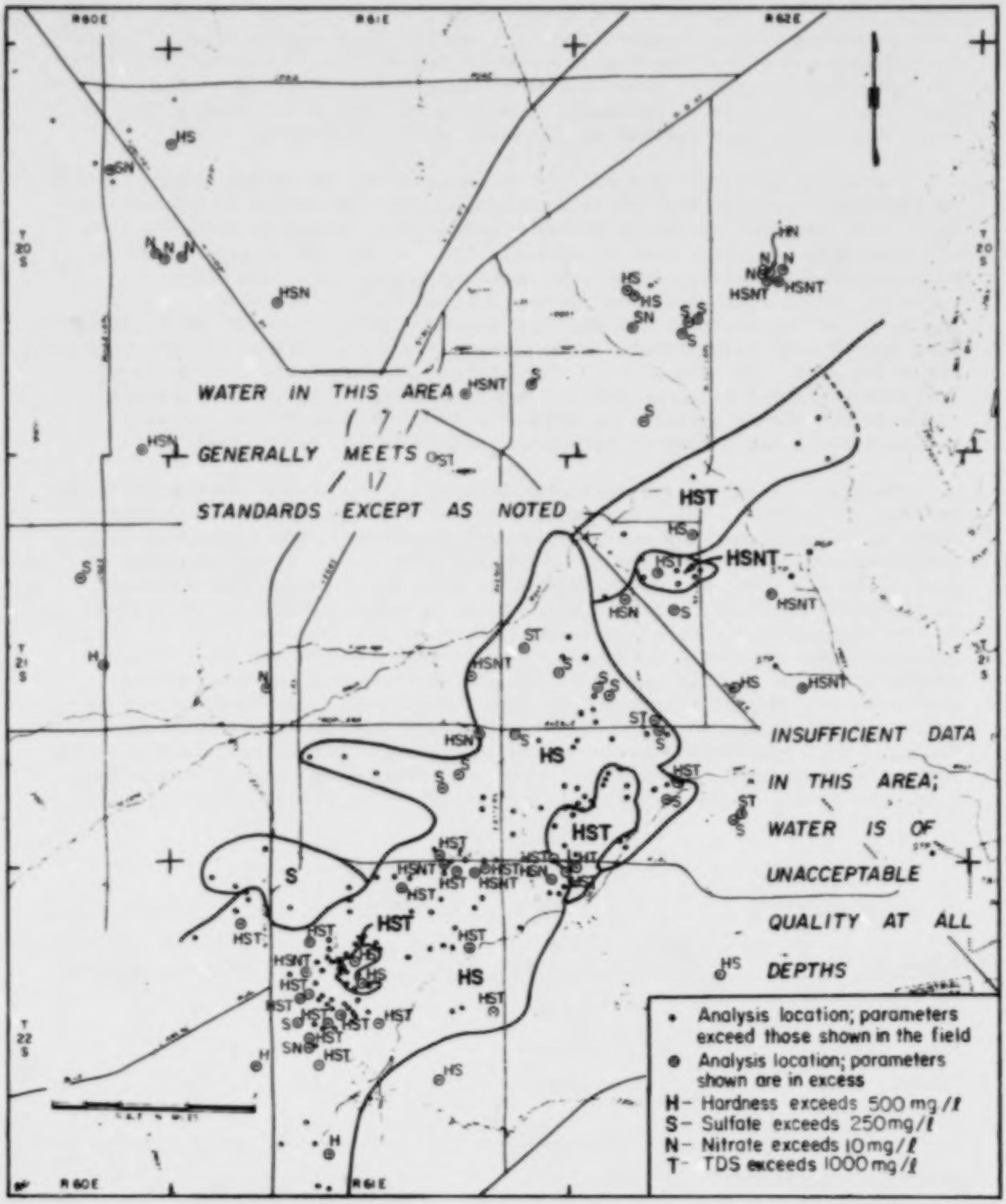

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
WATER IN THIS AREA GENERALLY MEETS STANDARDS EXCEPT AS NOTED
INSUFFICIENT DATA IN THIS AREA; WATER IS OF UNACCEPTABLE QUALITY AT ALL DEPTHS
HST
HSNT
HS
S
• Analysis location; parameters exceed those shown in the field
◉ Analysis location; parameters shown are in excess
H- Hardness exceeds 500 mg/l
S- Sulfate exceeds 250 mg/l
N- Nitrate exceeds 10 mg/l
T- TDS exceeds 1000 mg/l

Figure 40. Locations of wells 101 to 300 feet deep with inferior water quality.

A nitrate threshold of 10 mg/ℓ was chosen because concentrations at depths of 101 to 300 feet are normally below 10 mg/ℓ. Thus, although nitrate concentrations to data rarely exceed the maximum permissible limit (45 mg/ℓ) in drinking water, nitrate trends shown in Figure 40 are believed indicative of areas where bacterial contaminants or dangerous nitrate concentrations are most likely. This is particularly true of areas served by shallow domestic wells and septic tank systems as in 20/61, 20/62, 21/62, and 22/61.

Hardness, sulfate and TDS are the most common parameters exceeding the recommended levels in the Valley and are probably the result of natural factors. For example, excessive hardness and sulfate generally coincide with the Duck Creek drainage area in Paradise Valley, an area of gypsiferous soils, high evapotranspiration and poor to moderately permeable sediments. As expected, wells with excessive TDS are located farther eastward, i.e., in the downgradient position of the flow system. In 21/62, high TDS is associated either with high nitrate or is present along the extreme eastern edge of the study area. The association with nitrate is considered indicative of infiltrated sewage effluent and(or) septic tank leachate whereas minimal recharge and highly gypsiferous sediments on the flanks of the Frenchman Mountain block could account for hardness-sulfate-TDS association.

Further utility of the data bank created in the course of the study can be seen in Figure 41 which was generalized from a computer generated plot of water analyses classified as to hydrochemical facies. The hydrochemical facies concept was developed by Chebotarev (1955 a, b, c) and utilized by Back (1961 and 1966) and Seaber (1965) in studies of ground-water quality in the Atlantic Coastal Plain. Briefly, 16 possible facies are identified on the basis of relative concentration (in milliequivalents/liter) of the principal ions expressed as a percentage of total anions and total cations (Table 13). For example, water containing 90 percent or more of sodium + potassium cations and 90 percent or more bicarbonate + carbonate anions is defined as belonging to the sodium + potassium: bicarbonate + carbonate facies. Chemical facies are a result of lithologic variations along the flow path, residence time in the flow system, and changes in mineral composition along the flow path due to solubility, ion exchange, precipitation, etc.

TABLE 13. CLASSIFICATION OF HYDROCHEMICAL FACIES
(adapted from Back, 1961 and Seaber, 1965)

Anion facies	Range in HCO_3+CO_3 content (as % of total anions)	Range in Cl+SO_4 content (as % of total anions)
HCO_3+CO_3	90-100	0-<10
HCO_3, Cl+SO_4	50-<90	10-<50
Cl+SO_4, HCO_3	10-<50	50-<90
Cl+SO_4	0-<10	90-100

TABLE 13 (continued)

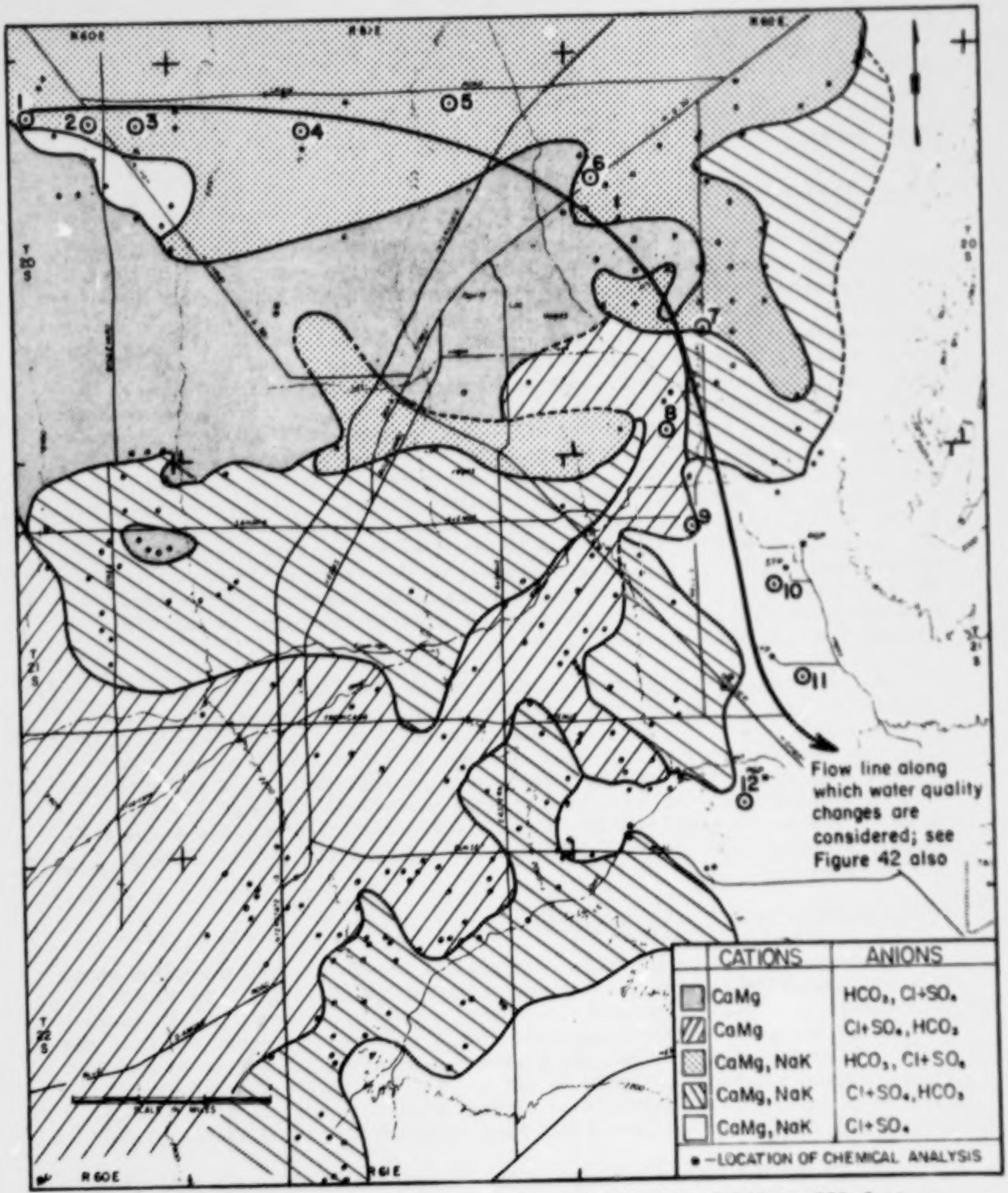

R 60 E
R 61 E
R 62 E
T 20 S
T 21 S
T 22 S
1
2
3
4
5
6
7
8
9
10
11
12
Flow line along which water quality changes are considered; see Figure 42 also
CATIONS
ANIONS
CaMg
HCO₃, Cl+SO₄
CaMg
Cl+SO₄, HCO₃
CaMg, NaK
HCO₃, Cl+SO₄
CaMg, NaK
Cl+SO₄, HCO₃
CaMg, NaK
Cl+SO₄
• —LOCATION OF CHEMICAL ANALYSIS
SCALE IN MILES

Figure 41. Hydrochemical facies in ground water at depths of 101 to 300 feet.

Cation facies	Range in Ca+Mg content (as % of total cations)	Range in Na+K content (as % of total cations,
Ca+Mg	0-<10	90-100
Ca+Mg, Na+K	10-<50	50-<90
Na+K, Ca+Mg	50-<90	10-<50
Na+K	90-<100	0-<10

Lateral variations or facies changes result from litholgic influences in the recharge areas, residence time in the aquifer(s), and changes in the mineral composition in the aquifer along the direction of flow. Variations in chemical character of water in the depth interval from 101 to 300 feet are most apparent along flow paths through the northern and central portions of the Valley. Figures 41 and 42 depict selected data points along a given flow line. The progressive change from calcium-magnesium-bicarbonate to calcium-magnesium-sulfate facies is believed a result of increased gypsiferous sediments, longer residence time, and possibly minor recharge from the Frenchman Mountain block. As expected, TDS also increases with distance along the flow path. Progressive increase in the percentage of sodium and potassium and decrease in calcium is indicative of ion exchange. In the central portion of the Valley, these comments also apply except the calcium-magnesium character is retained despite the anion shift from bicarbonate to sulfate. Along the southern limits of the urbanized area, ground water at depths of 101 to 300 feet is consistently of the calcium-magnesium-chloride-sulfate type. Chloride increases about three percent per mile of flow and, as expected, dissolved solids also increase slightly.

Periodic generation of hydrochemical facies maps and comparison of changes in patterns through time can provide an estimate of changing water quality conditions. The approach is most productive if used in conjunction with time series data for individual parameters (ions, ionic ratios, TDS, etc.) and specific wells or well fields. At present, data from the interval 0 to 50 feet partially characterize spatial variations in water quality. Temporal trends are qualitatively known, particularly where waste disposal, wastewater recycling, or other land use in characterized by distinctive return flows.

RETURN FLOWS OF INDUSTRIAL ORIGIN

In terms of both flow volume and chemical concentration, the major waste disposal operation adversely affecting ground-water quality is the Basic Management, Inc. (BMI) complex in Henderson. Operations began in the early 1940's and initially produced magnesium metal to support the war effort. The present chemical manufacturing and minerals processing industries or predecessor companies began operation in 1945, 1948, and 1950. Throughout the periods of operation, liquid effluents have been conveyed via open ditches to tailings ponds where disposal has been by evaporation and infiltration.

Initial effort in the study involved definition of the hydrogeologic framework and effects of industrial waste disposal in lower Las Vegas Wash.

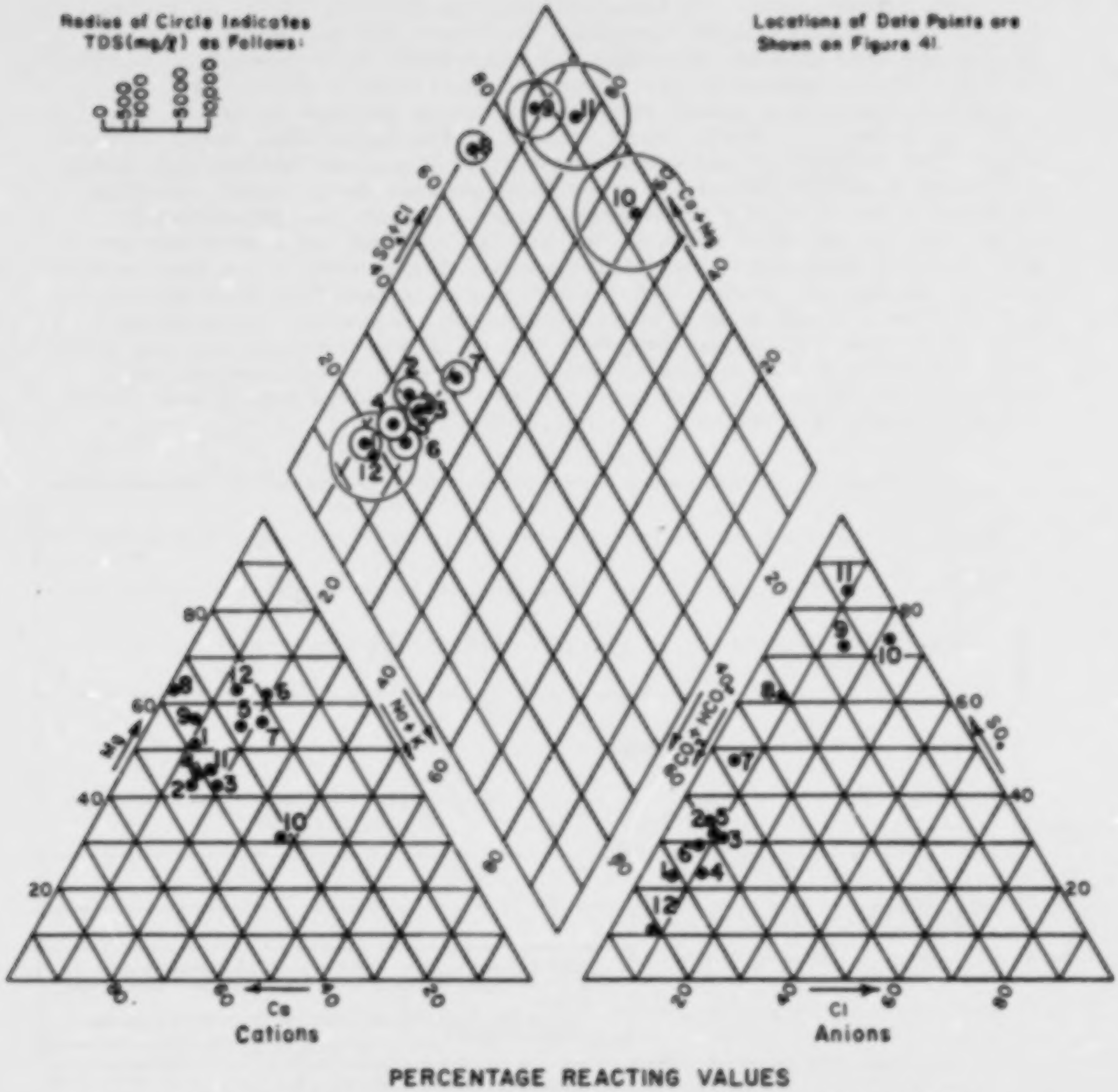


Figure 42. Piper diagram showing variations in ground-water quality along a selected flow path through Las Vegas Valley.

This involved assessment of lithologic boundary conditions and water quality (Kaufmann, 1971), waterlogging (Kaufmann, 1972), and combined paper analog and digital analysis of the flow regime (Westphal and Nork, 1972).

Ground-water inflow was first estimated by Kaufmann (1971) by taking into account the total monthly surface water flows into the Wash during 1970 as well as the Wash flow at Pabco Road and North Shore Road (located at stations LW003 and LW007, respectively). These are summarized in Figure 43. The hydrograph separations reveal ground water enters the Wash in the reaches above and below Pabco Road. Considering only the months when sewage effluent demand (for irrigation) and evapotranspiration losses are minimal and correcting total flow differences for other known surface water inputs, net flow differences are attributable to ground water. Net average ground-water return flow in the upper reach of the Wash is 3.37 MGD (10.3 acre feet per day), much of which exits the tailing ponds. Lesser amounts are from commercial irrigation with sewage, and "other" general return flow from sources such as lawn watering or golf course irrigation. Accretion in the reach below Pabco Road is approximately 5.67 MGD (17.4 acre feet per day) for a total accretion of 9.04 MGD (27.7 acre feet per day). This compares well with the value 10.68 MGD (32.8 acre feet per day) derived from a more detailed budget analysis of Westphal and Nork (1972).

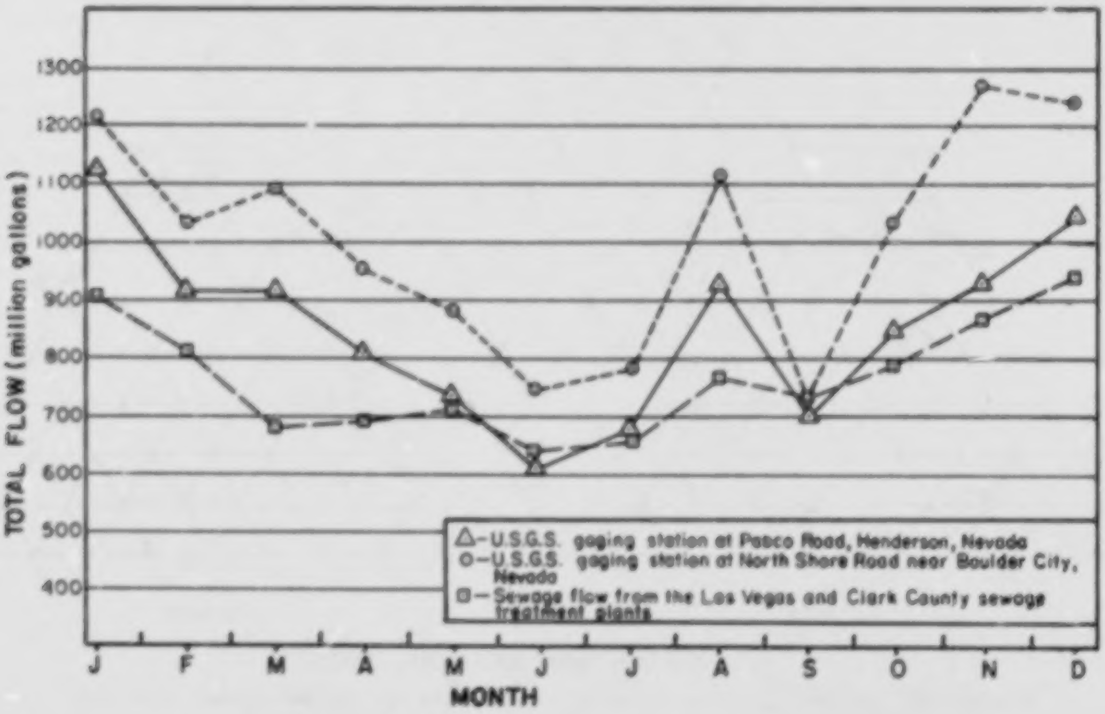
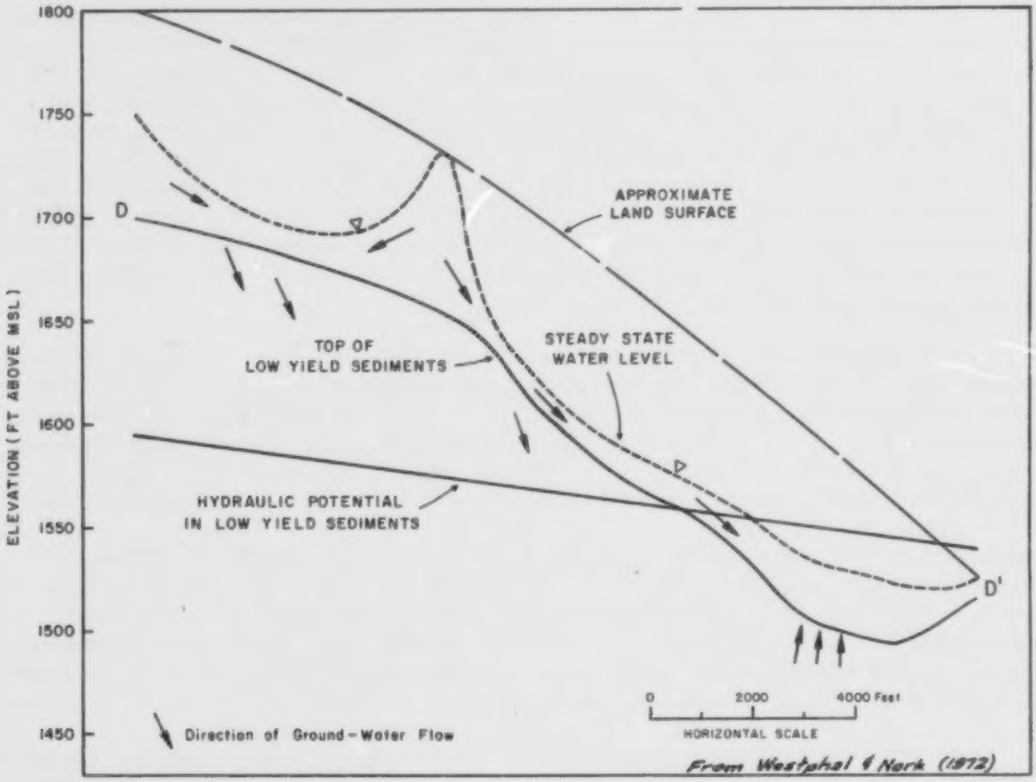


Figure 43. Hydrograph showing Las Vegas Wash discharge in 1970.

Recognizing that marked ground-water inflow occurs in the reach containing the tailings ponds, an effort was made to ascertain the flow path. The initial effort (Kaufmann, 1971) concluded that industrial return flow infiltrating via the tailings ponds and ditches entered the Wash after flowing laterally through thin (20 to 100 feet thick) and highly permeable sand and gravel deposits. Although this was true, the subsequent modeling study (Westphal and Nork, 1972) indicated that underlying, less permeable sediments also were involved and 7.3 MGD (22.4 acre feet per day) of effluent infiltrated. This latter explanation is shown in Figure 44 which depicts the shallow, saturated materials between the upper tailing ponds and Las Vegas Wash, and probable directions of ground-water flow. From the location of the trough between the southern boundary and the mound, the presence of wastewaters infiltrating from the upper ponds is indicated as far as 2,300 feet south of the ponds. It also appears that ground water in saturated materials downgradient from the mound is derived principally from percolation of effluent from the upper ponds. Significant vertical transfer of water into low-yield sediments must occur to satisfy the boundary conditions, aquifer characteristics, and system stresses.


1800
1750
1700
1650
1600
1550
1500
1450
ELEVATION (FT ABOVE MSL)
D
D'
APPROXIMATE LAND SURFACE
TOP OF LOW YIELD SEDIMENTS
STEADY STATE WATER LEVEL
HYDRAULIC POTENTIAL IN LOW YIELD SEDIMENTS
Direction of Ground-Water Flow
0
2000
4000 Feet
HORIZONTAL SCALE

From Westphal & Nork (1972)

Figure 44. Ground-water flow system cross-section in the area between the BMI tailings pond and Las Vegas Wash.

Variations in ground-water quality were determined with respect to lateral and vertical position relative to Las Vegas Wash and particularly in relation to the BMI tailings ponds and lagoons. Peak concentrations of chloride, nitrate, and TDS are located in areas extending from the plant area to Las Vegas Wash as shown in Figures 45, 46, and 47. It is apparent that pollutants have migrated extensively from the northern portion of the plant area and from the tailings ponds. This is confirmed by tritium data, particularly for stations LW020, LG030, and LG050.

Effects of industrial wastes on natural ground-water quality below the lagoons and lower ponds include greatly increased sodium and chloride (wells LG027 and LG028) compared to natural shallow ground-water quality tributary to the Wash from the south (LG029, LG030, LG019, and LG020) and the north (LG015 and LG016). Total dissolved salt concentrations are also noticeably increased. Ground water below the lagoons near the plants and in the lower ponds contains 5,000 to 32,000 mg/ℓ TDS in contrast to 2,000 ± 500 mg/ℓ in ground water free of industrial wastes as at LG015, LG016, and LG031.

At the time of the study influent to the upper ponds had a mean pH of 4.08 and increased concentrations of sodium (527 mg/ℓ), chloride (948 mg/ℓ) and nitrate (102 mg/ℓ) relative to natural shallow ground water in the surrounding area. The industrial effluent contains large concentrations of TDS, chloride, and nitrate, the latter originating as nitric acid used in ore processing. As expected, ground-water quality in the area north of the upper ponds is enriched in nitrate and chloride relative to background levels. Detailed relationships between effluent quality and ground-water quality are difficult to assess because of the lack of historical information. Tremendous variability in the quality of water discharged during the course of the study is apparent from analyses for stations LW022, 042, 043, and 044. Similar variability over the last three decades can be assumed. Also unknown is the volume of effluent discharged, the locus of discharge, i.e., upper ponds or lower ponds, and duration of use.

The quality of ground-water discharge into the Wash is shown in Table 14. Wells are at the depths indicated and are situated along or immediately adjacent to the Wash. They are arranged from left to right in the downstream direction and are paired, i.e., LG029 and LG030 constitute a piezometer nest, as do LG019 and LG020, etc. Wells on the southern edge of the channel and downstream from the treatment plants contain TDS concentrations ranging from 5,000 to 7,000 mg/ℓ. Nitrate data for well LG037 near the Clark County Sewage Treatment Plant indicate effluent infiltration and an increase in nitrate in the shallow zone from background levels of 0.1 to 3 mg/ℓ to 130 mg/ℓ. However, from this point downstream toward the tailings ponds, nitrate decreases to background level (wells LG029 and LG030) and then increases again in the vicinity of Pabco Road crossing (21/63-30c) due to influx of contaminated water evident in well LG020.

Further indications of high salt and nitrate loads in ground water tributary to the Wash downstream from Pabco Road include analyses from observation wells (LG004 through LG007) and from dewatering wells installed in connection with the Southern Nevada Water Project pipeline. The pipeline crossed under the Wash near station LW004, requiring dewatering of 30 to 35 feet of sediments over a period of several weeks. At the peak of the dewatering effort, approximately 20 to 30 MGD (61.3 to 92.2 acre feet per day) were withdrawn from the well network. Well LG051 contained about 4,500 mg/ℓ TDS, primarily calcium, sodium, and sulfate. With increasing distance

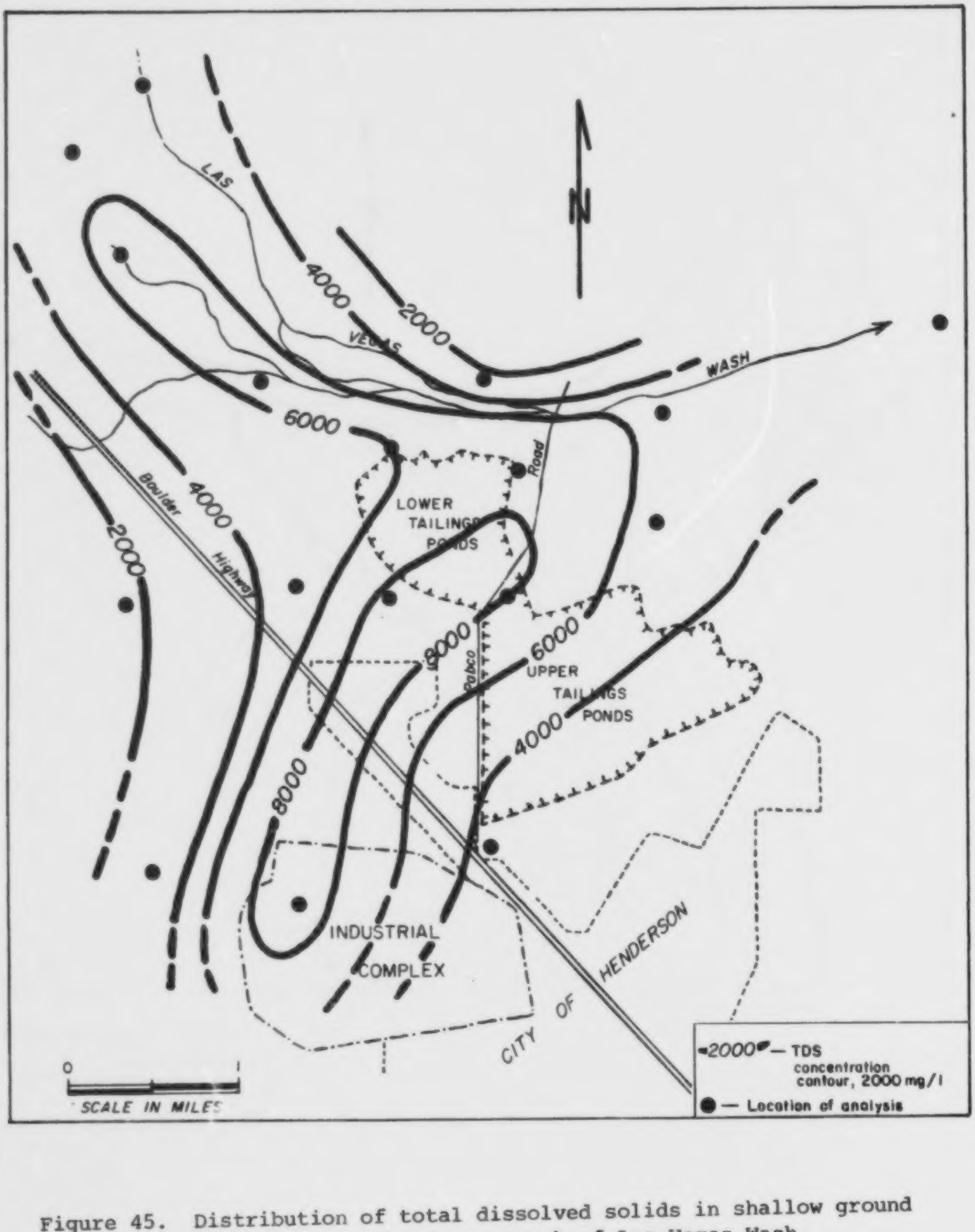

LAS
VEGAS
WASH
N
4000
2000
6000
4000
2000
Boulder Highway
Road
LOWER TAILINGS PONDS
8000
6000
Pabco
UPPER TAILINGS PONDS
4000
8000
INDUSTRIAL COMPLEX
CITY OF HENDERSON
0
1
SCALE IN MILES
2000 — TDS concentration contour, 2000 mg/l
● — Location of analysis

Figure 45. Distribution of total dissolved solids in shallow ground water adjacent to the lower reach of Las Vegas Wash.

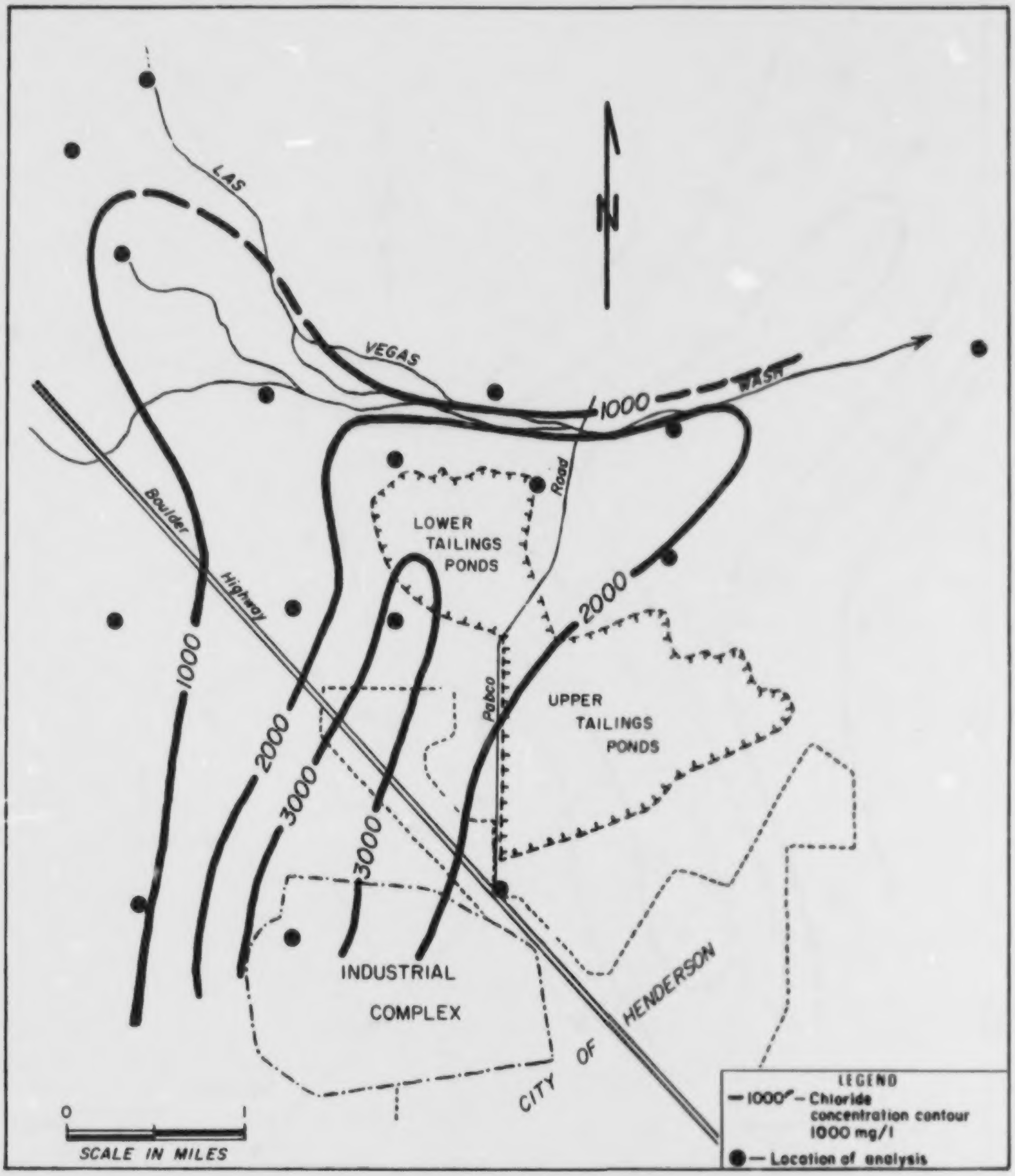

N
LAS
VEGAS
WASH
1000
1000
2000
2000
3000
3000
Boulder Highway
Pabco Road
LOWER TAILINGS PONDS
UPPER TAILINGS PONDS
INDUSTRIAL COMPLEX
CITY OF HENDERSON
0
1
SCALE IN MILES
LEGEND
1000 — Chloride concentration contour 1000 mg/l
● — Location of analysis

Figure 46. Distribution of chloride in shallow ground water adjacent to the lower reach of Las Vegas Wash.

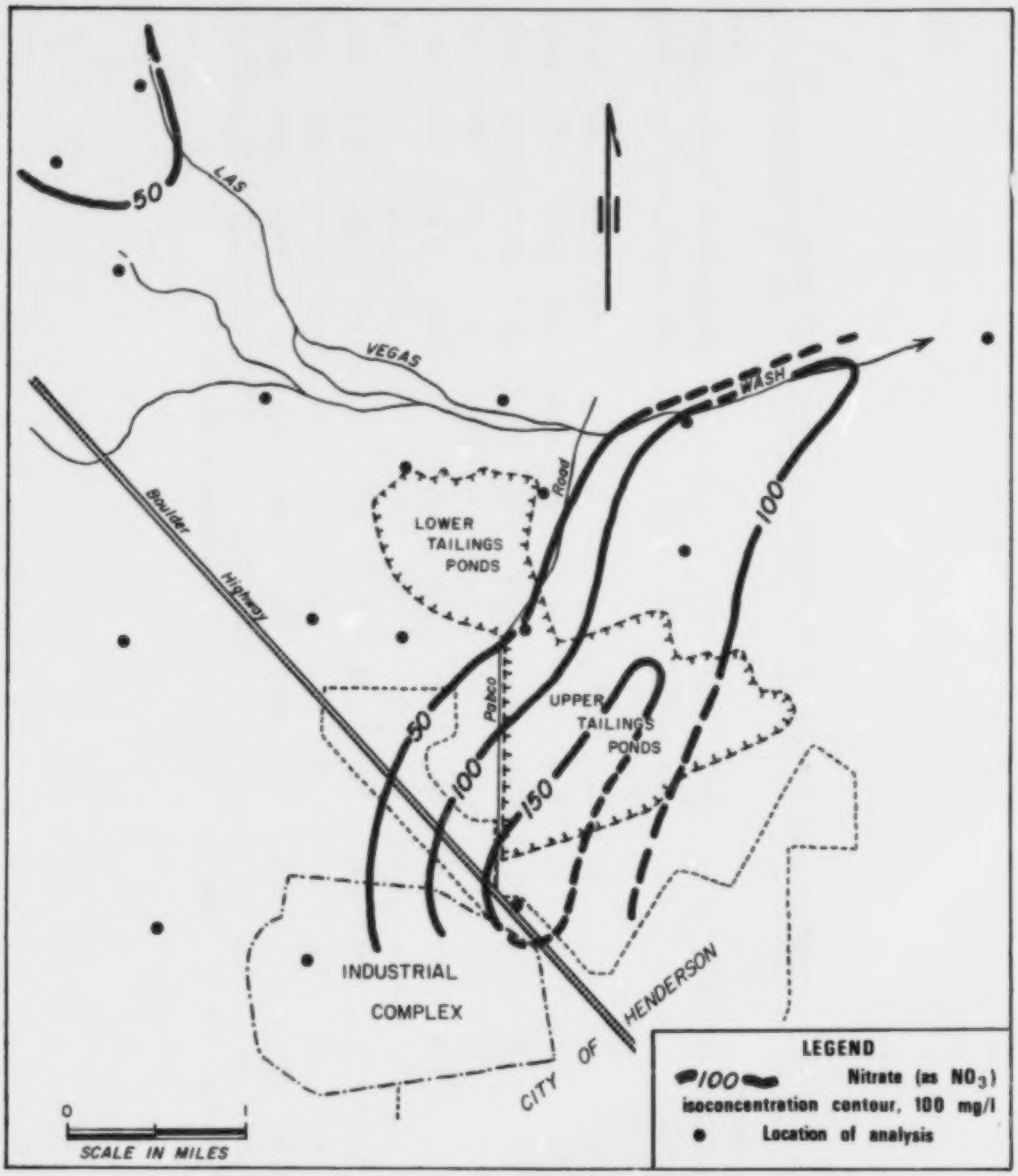

50
LAS
VEGAS
WASH
Boulder Highway
Road
LOWER TAILINGS PONDS
Pabco
UPPER TAILINGS PONDS
50
100
150
100
INDUSTRIAL COMPLEX
CITY OF HENDERSON
LEGEND
100 Nitrate (as NO3) isoconcentration contour, 100 mg/l
● Location of analysis
0
1
SCALE IN MILES

Figure 47. Distribution of nitrate in shallow ground water adjacent to the lower reach of Las Vegas Wash.

TABLE 14. GROUND-WATER QUALITY IN THE UNDERFLOW OF LAS VEGAS WASH*

		UPSTREAM													DOWNSTREAM
	Well	LG035	LG034	LG036	LG037	LG029	LG030	LG016	LG015	LG019	LG020	LG007	LG006	LG005	LG004
	Depth	102'	35'	45'	25'	97'	30'	47'	25'	60'	21'	134'	41'	95'	47'
Concentrations, mg/ℓ	Cl	46	427	856	980	507	1168	150	239	1180	2339	1178	1489	1476	1775
	SO_4	704	3087	2754	3602	2678	3228	1837	1010	3208	2670	1950	2103	2373	2383
	PO_4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	NO_3	0.12	53	58	130	<0.1	1.59	<0.1	0.11	<0.1	16.7	73	89	36	<0.1
	Na	87	674	751	1165	480	885	247	252	764	1560	689	782	1023	875
	K	11	41	26	30	70	111	25	26	177	46	82	83	72	88
	Ca	146	446	488	552	562	632	330	255	523	588	585	619	516	724
	Mg	96	354	318	353	306	456	215	103	420	269	270	302	341	436
	TDS	1193	5352	5317	6911	4811	6753	2993	2213	6320	7734	5069	5658	6130	6615

* Values shown from June 1971 samples. Well locations are shown in Figure 17.

southward from the Wash, nitrate, chloride, potassium, and sodium increase whereas calcium, magnesium, and sulfate decrease.

Considering these ground-water quality data, the ionic shifts in Wash water quality in the vicinity of the tailing ponds are understandable. As shown in Table 15, the most significant quality change by percentage is nitrate, which is low in concentration in the channel substrate at a depth of 42 feet or more (wells LG015, LG016, and LG017) but very high in shallow wells adjacent to the pond area (wells LG052, LG053, LG054, and LG055). These contained 152, 134, 168, and 116 mg/ℓ nitrate, respectively. A similar comparison can be made for chloride.

TABLE 15. LAS VEGAS WASH WATER QUALITY IN THE VICINITY OF HENDERSON

	Station			Percentage change
	LW003* (mg/ℓ)	LW004† (mg/ℓ)	LW005‡ (mg/ℓ)	$\frac{\text{LW005-LW003}}{\text{LW003}} \times 100$
Cl	654	860	1000	+53
SO_4	988	1178	1366	+38
PO_4	20	16	12	-40
NO_3	25	30	63	+152
Na	495	591	594	+20
K	30	40	51	+70
Ca	260	324	408	+57
Mg	107	139	179	+67
TDS	2833	3439	3909	+38

* Mean of 17 analyses for samples collected between February 1970 and July 1971.

† Mean of 11 analyses for samples collected between June 1970 and July 1971.

‡ Mean of 10 analyses for samples collected between April 1970 and July 1971.

High nitrate concentrations are characteristic of return flows from the upper ponds and part of the lower ponds. In addition, well LG055, which is flowing and only 35 feet deep, contains 407 TU, indicating the influx of very young ground water in this reach of the Wash (hydrologic significance of tritium is discussed in detail in the following section). Further downstream, head and tritium data from wells LG006 and LG007 indicate the spring pond adjacent to the Wash is also fed with tritiated, nitrate rich ground water indicative of industrial return flows.

The chemical load in Las Vegas Wash attributable to industrial waste seepage was determined as follows: 1) direct measurement of chemical concentration and discharge, and 2) indirectly as the mass flux difference between two adjacent stations on the Wash (Kaufmann, 1971). Stations LW029, LW048, and LW049 were established as sampling and gaging sites to monitor surface water flow of industrial effluent to the Wash. The remaining stations on the Wash are, in downstream order, LW003, LW041 and LW045, and LW004 and LW063. Calculated salt loads are shown in Table 16.

Table 17 shows effects of waste loading by comparing chemical concentration and mass already in the Wash to that from other sources at three points in the Wash (in consecutive downstream order: LW003, LW041-LW045, and LW004-LW063). Each station is alternately considered as a "basepoint" where mass flux is compared to mass flux at points upstream or downstream. The differential (between points in the Wash or between the Wash and the tributaries) divided by the mass flux at the basepoint indicates the contribution from ground-water or surface water sources tributary to the Wash in the reach considered (see also footnotes, Table 17). Using TDS for example, stations LW048 and LW049 contributed 107,306 and 126,281 pounds per day on March 11 and 30, 1971, respectively. This represents 24 and 31 percent additions of TDS to the Wash relative to the load present upstream from the influence area of the tailings ponds.

Mass flux calculations show significant contributions of salts and nutrient in the form of nitrate originating in the tailing ponds seepage. Considering mass flux in the Wash reach hydraulically above the ponds equal to 100 percent, additional contributions calculated for three segments (above Pabco Road, between Pabco Road and the gravel pit, from the gravel pit) of the reach influenced by the ponds are shown in Tables 16 and 17. In general terms, the salt flux or loading attributable to ground water contaminated by wastewater discharge approximately equaled that from all other sources. This underscores the need to consider ground water in any basin water quality management program to control pollutant discharge from Las Vegas Wash.

TABLE 16. EFFECTS OF GROUND-WATER RETURN FLOWS ON WATER QUALITY AND CHEMICAL MASS IN LAS VEGAS WASH

Date	Station	Discharge ‡		Concentration, mg/ℓ				Chemical mass, lbs/day			
		cfs	MGD‡	Na	Cl	SO_4	TDS	Na	Cl	SO_4	TDS
March 11, 1971*	LW048	1.231	0.796	1860	2378	2404	7794	26337	33921	31892	107306
	049	1.38	0.892	1880	2437	2141	7467				
	003	34.149	22.07	483	643	1131	3020	88872	118312	208104	555680
	041	11.903	7.693	495	646	1071	3227	103074	135540	216633	628595
	045	25.154	16.256	526	694	1091	3108				
March 30, 1971*	048	1.399	0.904	1880	2355	2409	7735	31506	39389	38237	126281
	049	1.703	1.1	1890	2359	2189	7411				
	003	35.95	23.22	464	585	985	2720	90016	113490	191090	527680
	041	15.02	9.70	460	596	1009	2753	99264	127268	213670	586827
	045	23.03	14.88	500	637	1064	2934				
July 7, 1971†	048	0.68	0.439	1824	2392	2482	7835	14032	18796	17733	66464
	049	0.773	0.500	1764	2408	2074	7183				
	003	14.33	9.26	618	860	1432	3749	47728	66418	110593	289535
	004	15.508	10.02	704	1170	1681	4571	62522	103836	148362	403152
	063	0.972	0.628	704	933	1504	4037				
	029	6.17	3.99	526	1907	1588	5535	17505	63465	52849	184205

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* Based on one set/station of discharge measurements and water samples, collected from 0900-1040H.

† Based on mean values for water quality and discharge. Two water samples and two discharge measurements collected at stations LW029, LW048, LW049 whereas stations LW003, LW004, LW063 were each gaged and sampled three times. All data were collected in the period 0930-1700H.

‡ One MGD = 3.069 acre feet per day.

TABLE 17. PERCENTAGE OF SODIUM, CHLORIDE, SULFATE, AND TOTAL DISSOLVED SOLIDS ADDED TO LAS VEGAS WASH BY GROUND-WATER RETURN FLOWS

Date	Na	Cl	SO_4	TDS	Remarks
March 11, 1971	42	40	18	24	*
	16	14	4	13	†
March 30, 1971	54	53	25	31	*
	10	12	12	11	†
July 7, 1971	42	39	19	30	*
	28	61	36	46	‡
Mean % *	46	44	21	28	
†	13	13	8	12	
‡	28	61	36	46	
Total %	87	118	65	86	

* Represents mass contributions (by percentage) to the Wash by the ponds in the reach above Pabco Road (LW003). Calculated from chemical mass loading (Table 16) as follows:

$$\frac{\text{LW048} + \text{LW049}}{\text{LW003} - (\text{LW048} + \text{LW049})} \times 100$$

† Represents mass contributions (by percentage) to the Wash in the reach between Pabco Road (LW003) and Gravel Pit Road (LW041, LW045). Calculated from chemical mass loading as follows:

$$\frac{(\text{LW041} + \text{LW045}) - \text{LW003}}{\text{LW003}} \times 100$$

‡ Represents mass contributions (by percentage) to the Wash attributable to water exiting the Stewart Brothers gravel pit. The mass added is calculated as the percentage addition to that already present in the Wash at stations LW004 and LW063 as follows:

$$\frac{\text{LW029}}{\text{LW004} + \text{LW063}} \times 100$$

TRITIUM AS AN INDICATOR OF RETURN FLOWS

Introduction

The foregoing sections describing ground-water quality variations through space and time are largely developed from analysis of gross chemical data. In the lower Las Vegas Wash area, tritium data proved particularly diagnostic of the presence of return flows. Subsequent phases of the study also utilized this technique in the remainder of the Valley, portions of which have received tritiated Colorado River water since 1955.

Under certain conditions, tritium, a radioisotope of hydrogen, can be a useful tool in determining age and source of ground water. Use is made of environmental tritium rather than artificial introduction as a tracer. Atmospheric detonation of the first hydrogen bomb in March 1954, and other hydrogen bomb tests between 1954 and 1961, in particular, introduced large quantities of tritium to the atmosphere and subsequently to precipitation. For Las Vegas Valley, recharge occurs primarily from precipitation in the Spring Mountains, the Sheep and Las Vegas Ranges, and, to lesser extent, from rainfall and runoff incident to the Valley floor. Because of relatively long travel times, tritium in Las Vegas Valley ground water derived from recharge in mountainous areas is absent or at background levels of less than five tritium units (TU; one TU is equivalent to one atom of tritium in 10^{18} atoms of hydrogen). Tritium of higher concentrations could be found in areas of the Valley where recharge has been from infiltrated runoff, or return flow from imported Colorado River water. Because Colorado River water has been distributed in roughly the eastern half of the Valley since 1955, tritium is expected in return flows from such water usage. The concentration of tritium in the Colorado River has been significant but highly variable ($<$ 100 to 750 TU) in the period 1955 to 1973. Colorado River water was used as the only source of water in the Henderson area beginning in 1942. For the remainder of the Valley, but excluding North Las Vegas as well as western and northwestern Las Vegas, River water was used from 1955 through the summer of 1971 for summer peaking purposes only and at a maximum flow rate of about 57 acre feet per day. After September 1971, the Southern Nevada Water Project (Phase I) was completed and river water was used on a year-round basis in the eastern part of the Valley, i.e., roughly east of Las Vegas Boulevard.

Of interest to the present study is use of Colorado River water in the period 1955 through the summer of 1971. During this period there was rapid growth in population and widespread introduction of tritiated river water for use in lawn watering. Although use of such water increased greatly in 1972, effects of this usage were not recognizable within the time frame of the study.

Because of the complex distribution system in the service area of the Las Vegas Valley Water District and because River water was used only intermittently for peaking purposes from 1955 to 1971, quantitative estimations of the concentrations of tritium entering shallow ground-water resources is impossible. Only Henderson and the BMI industrial complex used Colorado River water exclusively.

Certain areas of low density residential development are served by individual domestic wells generally 300 feet or less in depth and tapping the unconfined aquifer. Tritium is therefore not particularly diagnostic of return flows under these conditions. Instead, nitrate was used as an indicator insofar as these same areas are also served by septic tank disposal systems. For the remaining areas of the Valley and for the bulk of the population and water uses dependent on public water supplies, comparisons of tritium content in ground water were made considering the probable source of local recharge and the age of nearby developed areas which range from the early 1940's to the early 1970's. In this manner, tritium was used to qualitatively assess the occurrence of recharge by irrigation return flows.

Despite the foregoing complications and limitations, tritium is diagnostic of return flows under the following circumstances:

1. Tritium in ground water beneath areas served partly by Colorado River water is indicative of return flows from irrigation and other urban-related sources.

2. Shallow ground water in areas not served by Colorado River water but containing higher concentrations (i.e., >5 TU) is probably recharged by in-valley precipitation and runoff.

3. Areas served wholly by Colorado River water are expected to have maximum levels of tritium in ground water; this assumes that dilution is comparable to other areas in the Valley.

Water Sampling Network

Locations and descriptions of all the stations sampled for tritium are provided in Figure 48 and Appendix 6. If all of the tritium data are considered, the sampling points fall into six categories (Figure 49): 1) Colorado River (Lake Mead), 2) deep ground water from artesian aquifers, 3) Las Vegas Wash surface flow, 4) shallow ground water adjacent to irrigated areas in the Valley, 5) return flow from point sources tributary to Las Vegas Wash, and 6) influents and effluents from the City and County sewage treatment plants (LW027, LW034, LW061, and LW062) and localized, high volume return flows from the BMI tailings ponds (LW032, LW048, and LW049) or influent to the upper ponds (LW022).

Some points in categories 3, 4, and 5 fit into more than one group, by virtue of their location. For the most part, samples in category 4 are from a variety of drains, seeps, springs, wells, and excavations throughout the Valley. The data in category 5 are from very shallow wells penetrating the uppermost few feet of the water table and are immediately adjacent to established residential areas irrigated, for the most part, with River water.

Tritium in Las Vegas Valley Water

When considering source and distribution of tritiated water, it is necessary to consider precipitation and runoff within the Valley, sources of recharge to the deeper ground-water reservoirs, and general relations of the Colorado River system water. Tritium rainout in the United States through

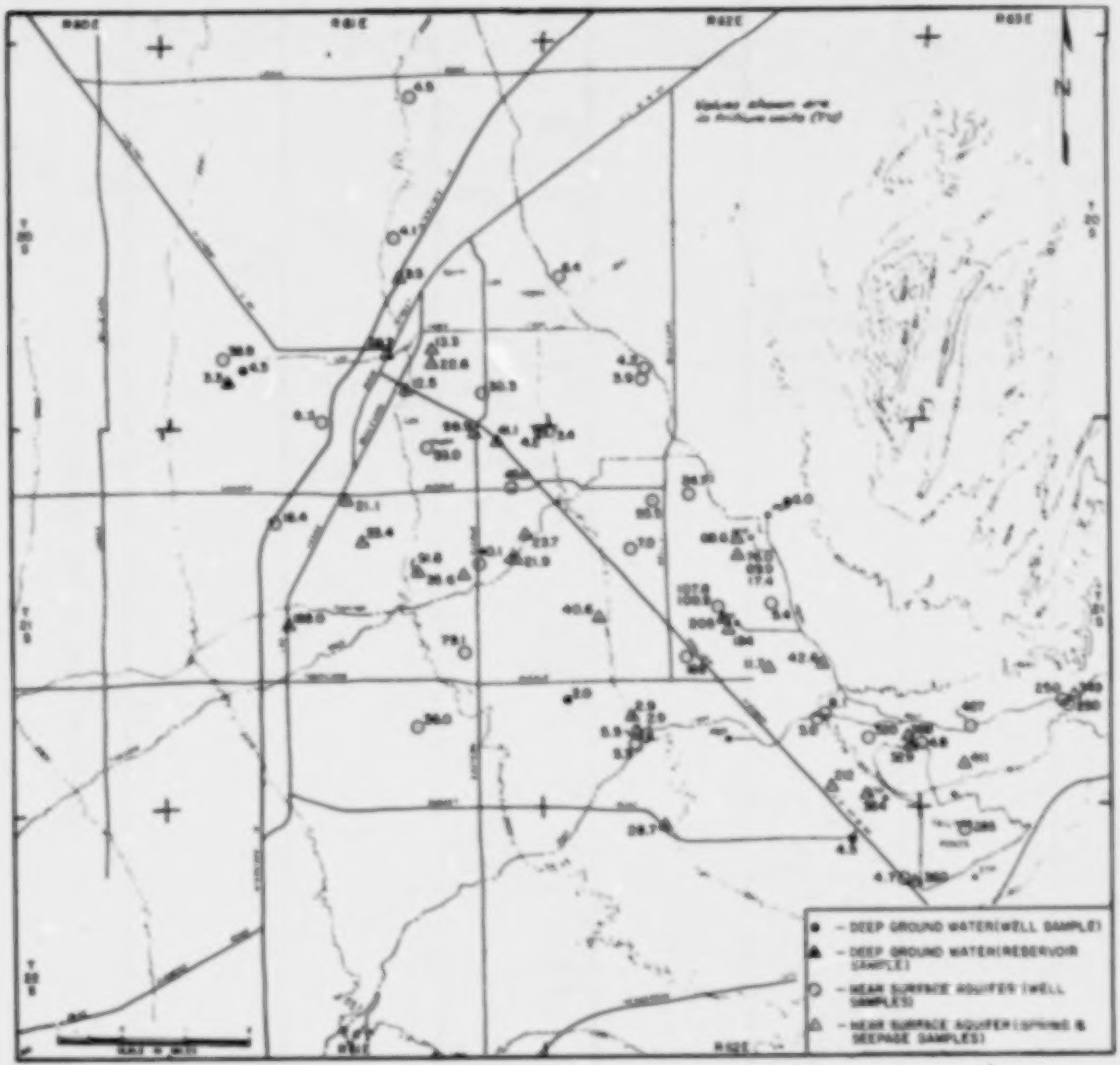

R61E
R62E
R63E
N
Values shown are in tritium units (TU)
● – DEEP GROUND WATER(WELL SAMPLE)
▲ – DEEP GROUND WATER(RESERVOIR SAMPLE)
○ – NEAR SURFACE AQUIFER (WELL SAMPLES)
△ – NEAR SURFACE AQUIFER (SPRING & SEEPAGE SAMPLES)

Figure 48. Locations of surface water and ground-water stations sampled for tritium.

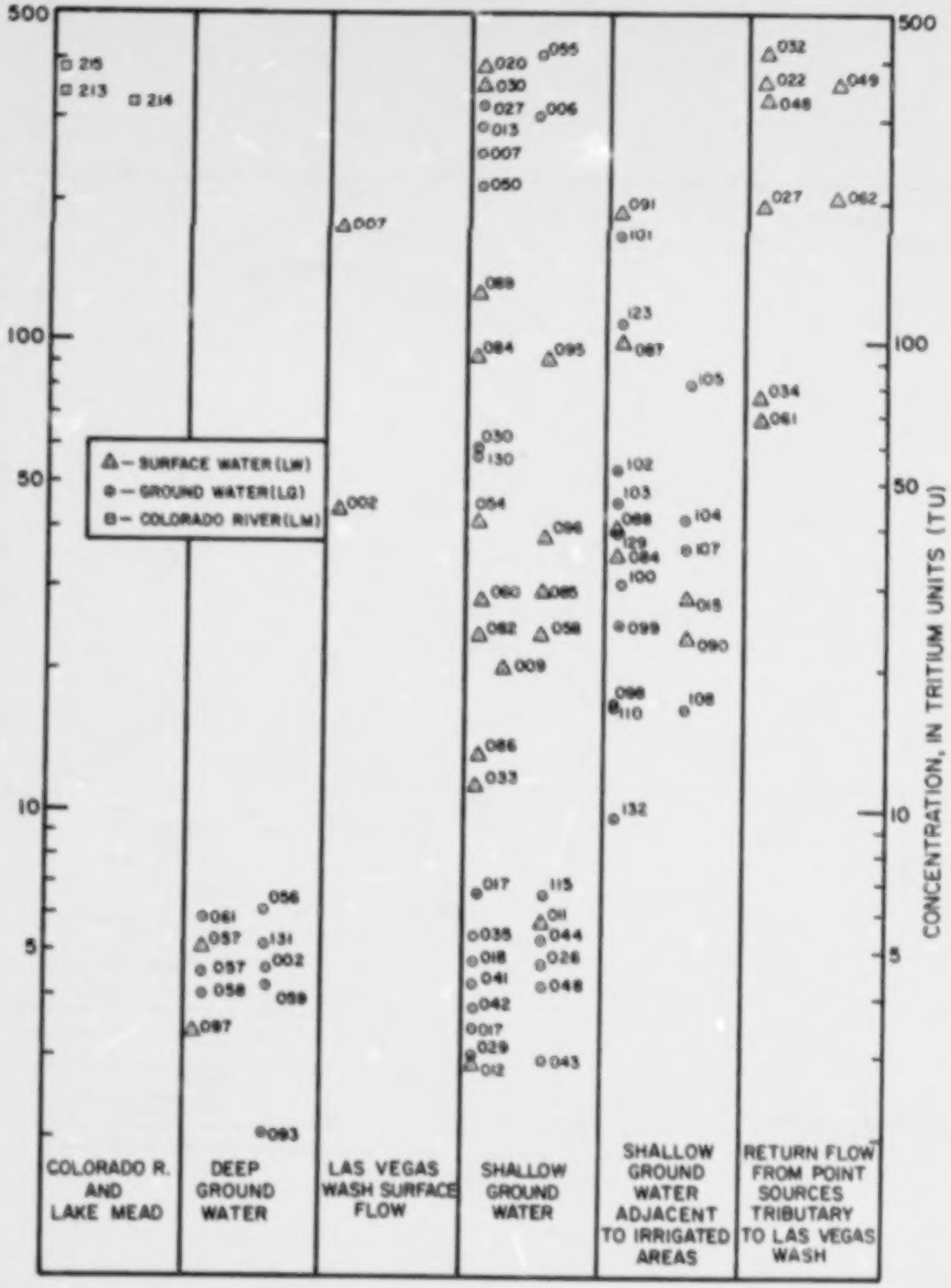


Figure 49. Tritium concentrations versus water type.

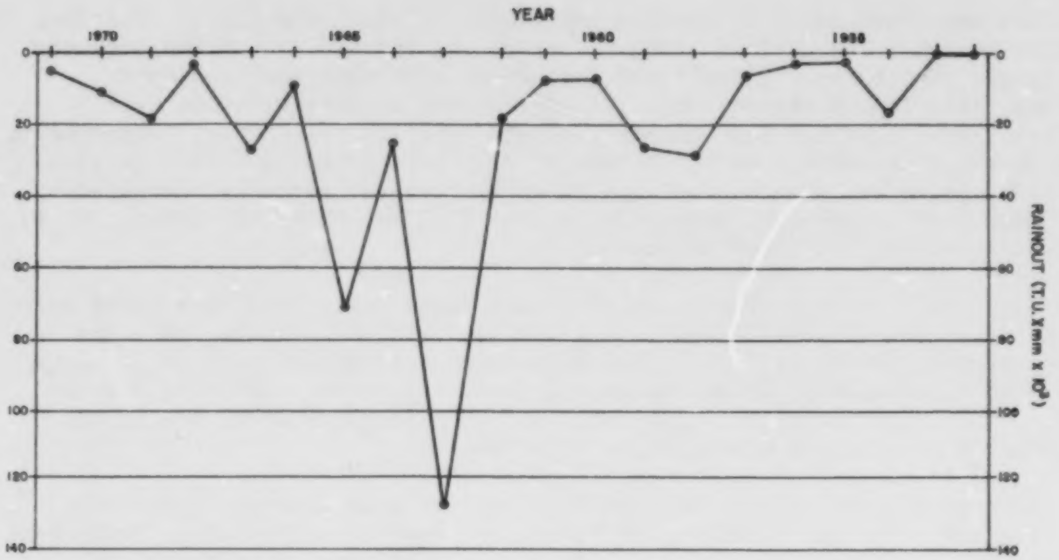
1968 has been summarized by Kaufman and Libby (1954), Libby (1962), Thatcher (1962), Thatcher and Hoffman (1963), Stewart and Hoffman (1966) and Stewart and Farnsworth (1968). Unpublished data since 1968 were supplied by T. Wyerman (written communication). Concentrations in precipitation over southern Nevada for the last decade are only approximately known. Atmospheric tritium was first monitored at the Nevada Test Site in early 1969. In 1971 and 1972 spring peaks were about 150 TU and 90 TU, respectively, compared to 75 TU and less than 50 TU, respectively, for 1969 and 1970 (H. Classen, U. S. Geological Survey, oral communication).

Long-term precipitation records for Las Vegas Valley indicate above average rainfall from 1912-1923 and from 1930-1941. In the intervening years, and particularly from 1942-1971, there has been a long-term deficit in rainfall with noticeable positive departures from the average occurring only in 1949, 1952, 1955, and 1965. Long-term average precipitation is 4.4 inches per year, whereas pan evaporation is about 90 inches.

Estimated local tritium rainout from 1952-1971 is shown in Figure 50. Due to weapons testing, the largest pulse over most of the northern hemisphere was in 1963. A second peak in 1965 was a result of above average rainfall over much of the country, despite the reduced concentrations of tritium relative to 1963. Although large rainout pulses occurred in 1963 and 1965, they followed over two decades of below normal precipitation in the Valley. From 1959-1963, cumulative precipitation was 5 inches below average. This deficit increased to 8.4 inches by 1965. Therefore, except along wash channels and in areas of ponded water, it is unlikely that rainfall of 7.96 inches in 1965 resulted in widespread, in-valley recharge.

Prior to September 1971, deep aquifers supplied the majority of water distributed in the Valley. This is particularly true for the area west of Main Street and in North Las Vegas. Average tritium content in the deeper, artesian aquifers is 4.6 TU. The range for 5 samples is 4.1 to 5.1 TU and comparable to values for Corn Creek Springs (4.8 TU) in an area of the Valley 20 miles northwest of Las Vegas, and to a composite sample of the West Charleston well field of the Las Vegas Valley Water District (3.3 TU). The discharge from Corn Creek Springs most likely is via conduits originating in deep-seated carbonate strata subcropping beneath the valley fill. Therefore, this water is regarded as "dead", i.e., not recently recharged. This is also true for deep, artesian aquifers underlying Paradise Valley (LG093) and Pittman (LG002) which contained 2.0 and 4.5 TU, respectively.

Relatively shallow observation wells were installed in the course of the study along the upper reach of Las Vegas Wash (LG041, 042) and along the main scarp through the Valley (LG043, 044, 047, 048). Tritium in these ranged from 2.9 to 5.3 TU, indicating that recent recharge of tritiated water to the water table at depths of 48 to 168 feet did not occur. Stations LG041 and LG042 are within 100 feet of the Wash axis which is expected to be a locus of recharge insofar as this reach has a depressed water table and carried flow for practically every runoff event in the Valley. However, at another location (LG055), bed infiltration of stormwater runoff apparently was related to improvement of the Flamingo Wash channel upstream from Nellis Boulevard. Before the drainage ditch was constructed, no through-flowing streams or stream channels traversed the area. After construction of the east-west



Year	TU*	Precipi- tation† (mm)	Year	TU*	Precipi- tation† (mm)
1952	2.5	177	1962	500	37
1953	12	15	1963	1300	98
1954	140	121	1964	900	28
1955	20	152	1965	350	202
1956	60	52	1966	200	49
1957	50	126	1967	190	141
1958	250	115	1968	130	28
1959	250	106	1969	140	129
1960	70	112	1970	100	109
1961	100	81	1971	80	65

* Precipitation before 1952 is estimated to contain 2 to 10 TU depending on location and local weather patterns (Kaufman and Libby, 1954; Libby, 1961). Values from 1953 through 1971 are based on contour maps of the U. S. including correlation with Ottawa, Canada (T. A. Wyerman, written communication; Stewart and Farnsworth, 1968; Stewart and Hoffman, 1966; Stewart and Wyerman, 1970; Wyerman et al., 1970). Unpublished U. S. Geological Survey data for the Nevada Test Site (H. Claassen, oral communication) and U. S. Environmental Protection Agency data (D. Wruble, written communication) for Las Vegas Valley were also utilized.

† U. S. Department of Commerce, Environmental Data Service Records for Las Vegas, Nevada.

Figure 50. Approximate Tritium Rainout at Las Vegas, for the period of 1952-1971.

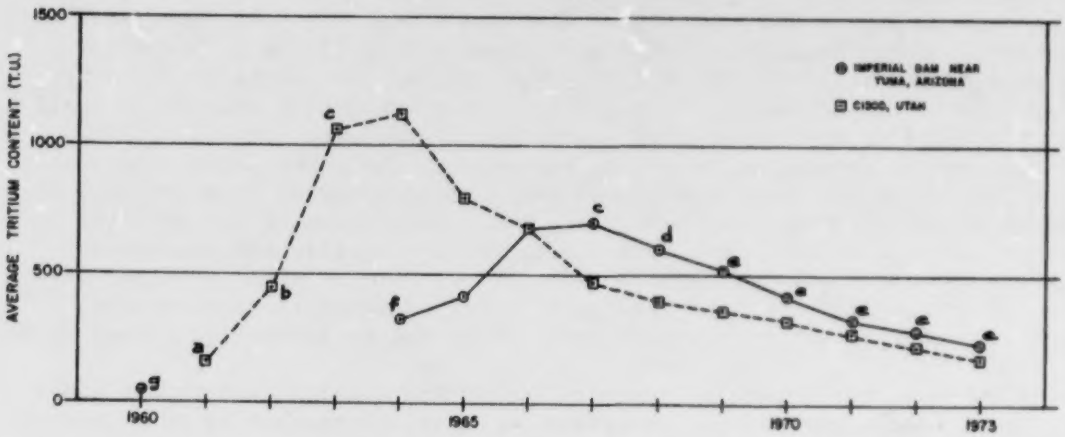
trending channel across the north quarter of 21/61-8, perennial spring discharge originating in the vicinity of stations LW084, 072, 008, 009, 060, and 077 (in downstream order) and occasional flash floods flowed in the ditch. As a result, TDS in a well 90 feet deep and located just south of the ditch and west of Nellis Boulevard tripled in a six month period causing the well to be abandoned in 1971 after many years use. Subsequent sampling yielded 55.5 TU, clearly indicative of recent recharge to the water table. Samples from three of the stations cited above and located upstream from the well in question contained from 21.9 to 35.6 TU, again indicative of the addition of recent, tritiated return flows to the near surface aquifer and subsequent discharge in small springs. As discussed below, some of these stations may reflect recharge from overland flow as a result of precipitation, whereas others with significant tritium are more likley due to irrigation return flows.

In summary, the foregoing comments concerning rainfall and runoff indicate the probability of local, in-valley recharge. Attention is now directed to what is believed to be the more significant recharge source, namely return flows from urban irrigation and from industrial waste disposal, both of which are closely related to the Colorado River water supply source.

Beginning in 1965, the concentration of tritium in the Colorado River was monitored monthly at Cisco, Utah and at Imperial Dam, California. Random samples were collected as early as 1961 and 1964 at the Cisco station and Imperial Dam, respectively. The 1961 to 1968 data presented by Wyerman et al. (1970) and unpublished data for 1969 to 1973 (T.A. Wyerman, written communication) are summarized in Figure 51 to show average annual tritium concentrations in the Colorado River. Annual average tritium content at Imperial Dam near Yuma in the last 13 years ranged from 52 to 710 TU, whereas concentrations in the upper basin at Cisco, Utah ranged from 141 to 1,126 TU. The variation between the Cisco and Imperial Dam stations on the Colorado River reflect difference in latitude, continental effects, and more importantly, transit time in the river system, which is increased because of the major impoundments. The highest level at Cisco was in 1963 and 1964, whereas at Imperial Dam the peak occurred in 1966-1967. Tritium in Colorado River water distributed within the Valley since 1961 can be roughly estimated as the straight line average of the Cisco and Imperial Dam values (T.A. Wyerman, written communication).

From Figure 51, it is estimated that tritium in the Colorado River water imported into Las Vegas Valley peaked at about 750 TU in 1963 and 1964, with a uniform decline to approximately 200 TU in 1973. Concentrations in the period 1953-1963 are little known but probably are on the order of 10 TU or less in 1953 and early 1954. Peaks of several hundred TU may have occurred in 1958 and 1959 followed by a second period of decline before levels reached a maximum in 1963.

The service areas of the City of Las Vegas and Clark County Sanitation Districts and the Las Vegas Valley Water District distribution (pressure) zones are shown in Figures 52 and 53. Tritium in the influent to the City and County sewage treatment plants as of June 29, 1971 was about 70 TU and 200 TU, respectively, which is indicative of the tritium concentration in return flows at that time. This difference (70 versus 200 TU) is expected because about one-half of the service area for the City plant was supplied almost solely with deep well water, whereas the County plant services an area



a) Samples collected only in September and October
b) Samples collected only in August
c) Average of 9 monthly samples
d) Average of 10 monthly samples
e) Average of 11 monthly samples
f) Sample collected only in November
g) Concentration in water delivered to Southern California in February 1960 (Libby, 1961)

Figure 51. Average annual tritium content of the Colorado River water.

largely dependent on River water or a mixture of River water and ground water. Insofar as the Colorado River contained about 350 TU in 1971, the concentration of 70 TU in influent to the City Sewage Treatment Plant indicates that about two-thirds of the water delivered was ground water with the balance from the Colorado River. For the County Treatment Plant, there are about equal proportions of river water and ground water. Prior to 1971, the approximate areas receiving river water and the volumes delivered are shown in Figures 53 and 54, respectively. Although much more widespread use of River water began in September 1971 as a result of the Southern Nevada Water Project, the author believes that 1973 tritium data accurately document ground-water conditions prior to any significant influences from Project water. This assumption is believed justified considering the time necessary for infiltration and migration of return flows from areas of application to sampling points.

There is abundant evidence of tritiated Colorado River water recharging shallow ground water in the area of the BMI complex in Henderson. Here, tritium concentrations range from 212 to 411 TU in shallow ground water. At least locally the shallow ground-water reservoir contains the probable upper limit for tritium concentrations, considering original concentrations in the Colorado River and decay of 5.5 percent per year. In other words, dilution of return flows has been essentially nil in this area. Recharge from the tailings ponds was estimated to be 9.3 MGD (28.5 acre feet per day) in December 1971, and at least 230,000 acre feet over the operating lifetime of the complex, hence extremely high concentrations of tritium in return flows are expected.

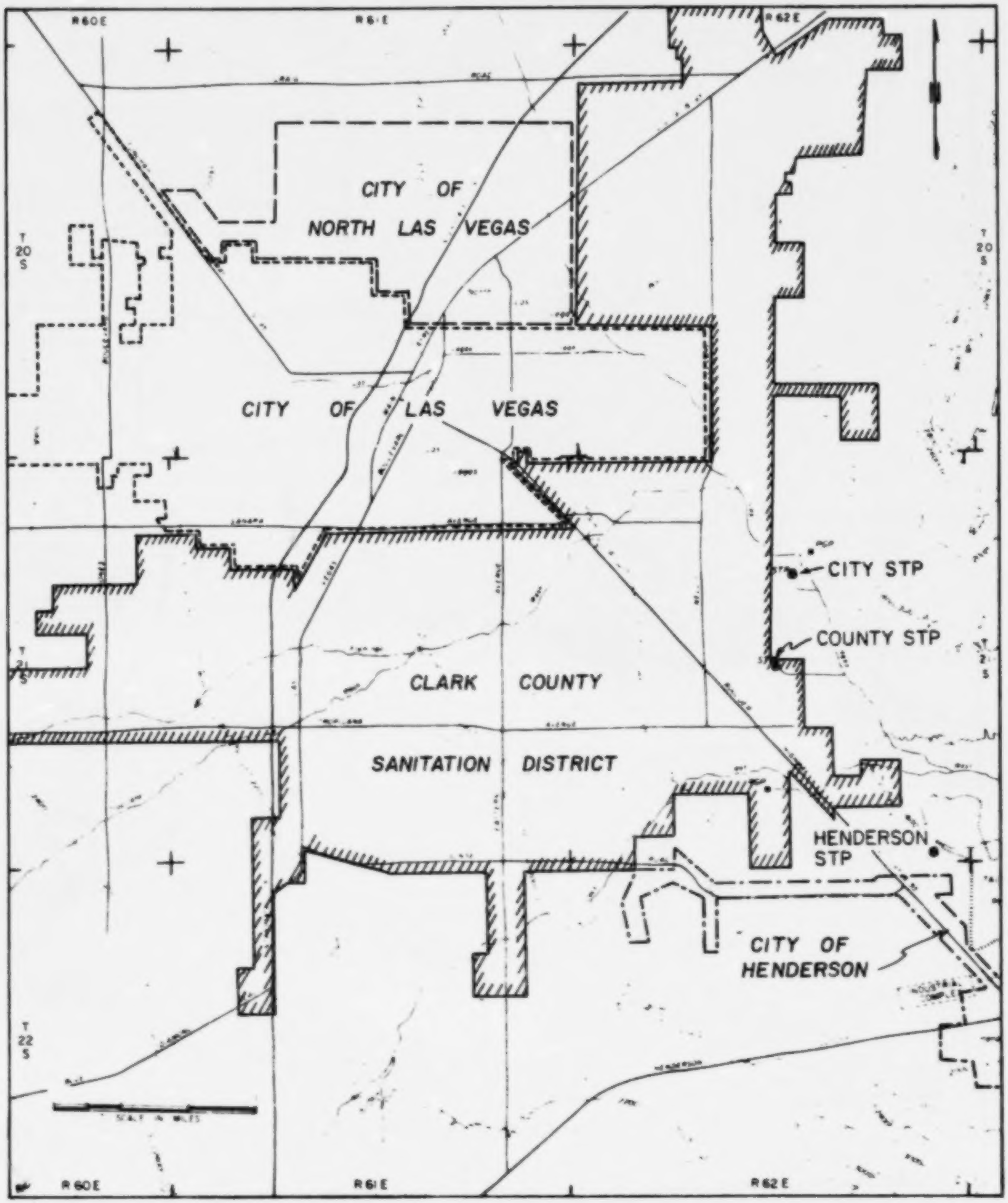

R60E
R61E
R62E
CITY OF NORTH LAS VEGAS
CITY OF LAS VEGAS
CLARK COUNTY SANITATION DISTRICT
CITY STP
COUNTY STP
HENDERSON STP
CITY OF HENDERSON
T 20 S
T 21 S
T 22 S
SCALE IN MILES
R60E
R61E
R62E

Figure 52. Map of the sanitation district service areas in Las Vegas Valley.

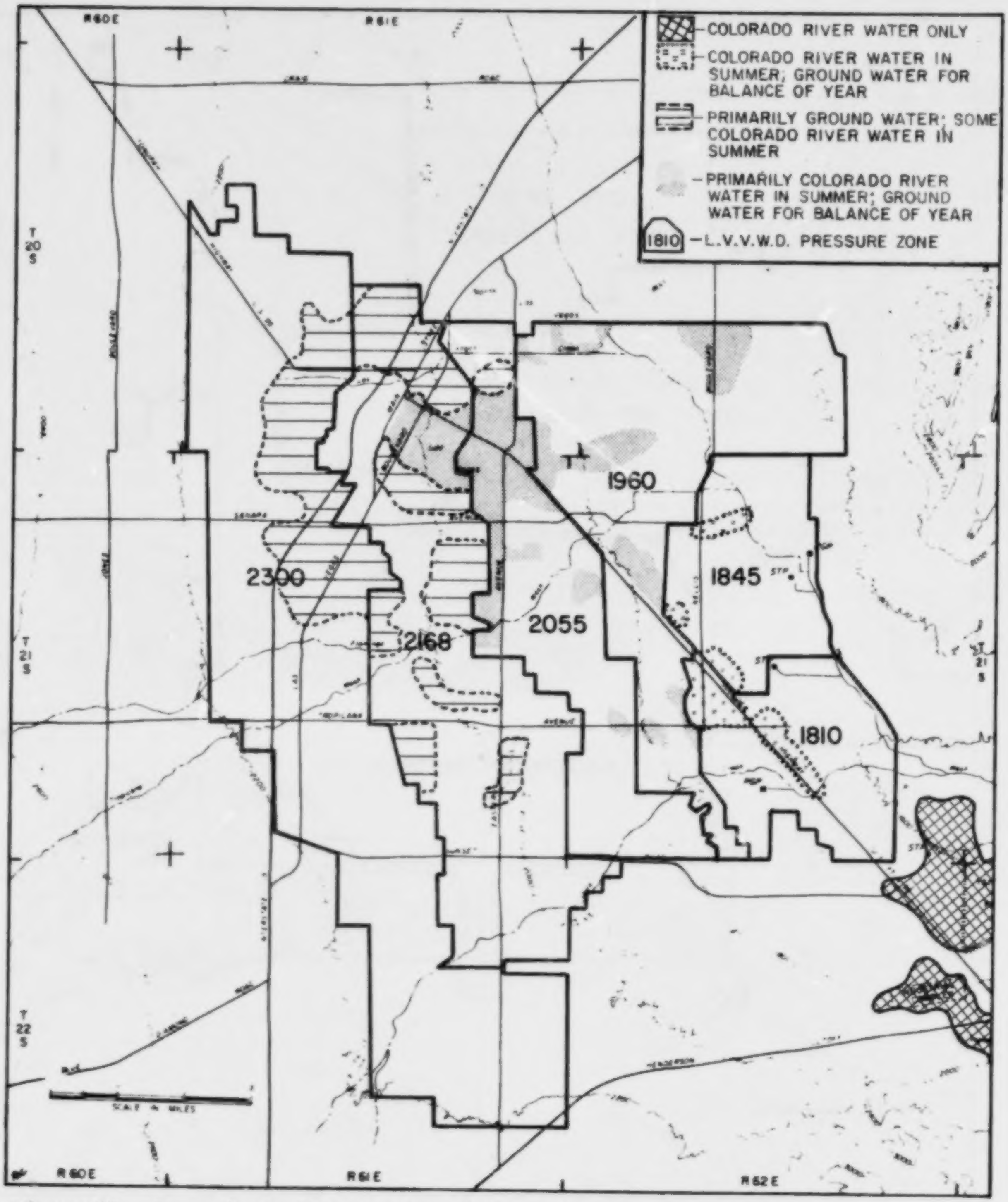

R60E
R61E
R62E
T 20 S
T 21 S
T 22 S
COLORADO RIVER WATER ONLY
COLORADO RIVER WATER IN SUMMER; GROUND WATER FOR BALANCE OF YEAR
PRIMARILY GROUND WATER; SOME COLORADO RIVER WATER IN SUMMER
PRIMARILY COLORADO RIVER WATER IN SUMMER; GROUND WATER FOR BALANCE OF YEAR
1810 — L.V.V.W.D. PRESSURE ZONE
1960
2300
1845
2168
2055
1810
SCALE IN MILES

Figure 53. Approximate distribution of Colorado River water in Las Vegas Valley Water District pressure zones from 1955-1971.

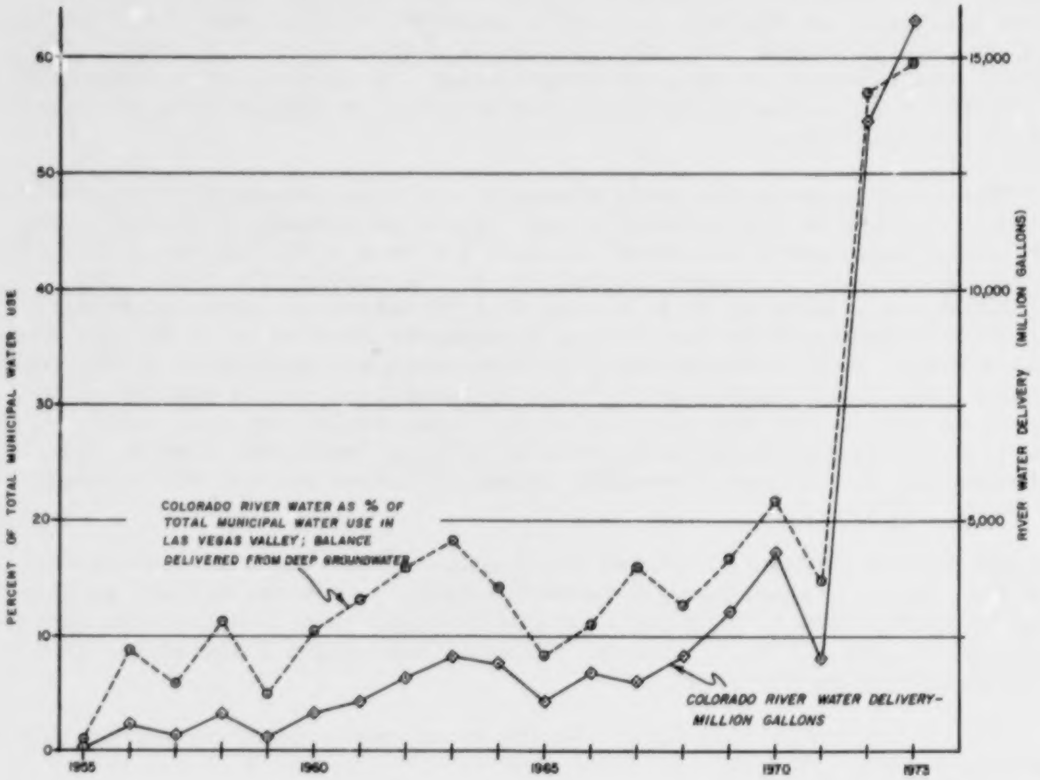


Figure 54. Colorado River water deliveries to Las Vegas Valley from 1955 through 1973 (exclusive of deliveries to BMI and Henderson).

Many indications of recharge from the ponds and ditches are described by Kaufmann (1971). For example, well LG050, which is 30 feet deep and located essentially downgradient from the plant area, was recharged by the effluent ditch leading from the plant area and then past station LW018 to the lower ponds. When the effluent was rerouted to the upper ponds in early 1971, well yield decreased sharply. The concentration of 212 TU probably reflects slight mixing of low-level, natural ground water with infiltrated industrial effluent. Station LW020, which contains 384 TU, is located at the terminal end of a french tile drain field extending generally southward toward Boulder Highway. Installed to allow farming in an area with a high water table, the tiles now collect shallow ground water heavily contaminated with wastewater originating in the plant area.

Tritium concentrations in ground water below and adjacent to both upper and lower tailings ponds indicate widespread contamination. Prominent springs (LW032, LW048, and LW049) created as a result of waste disposal contain tritium concentrations of 411, 329, and 358 TU, respectively. Below the upper pond area, which has most consistently received effluent since the early 1940's, piezometer LG013 (247 feet deep) contained 285 TU. This substantiates one of the early modeling results of this study, i.e., contamination has entered the less permeable sediments beneath the shallow sand and gravel. Contamination of the shallow, permeable sediments extends from the plant area northward 1.8 miles and from the upper ponds northeastward 1.5 miles. The overall area affected is about 16 square miles and consists of a swath 2 to 3 miles wide in an east-west direction and extending northward from the plant area to Las Vegas Wash.

Springs adjacent to the ponds discharge contaminated water isotopically similar to that from the Colorado River. Water from deeper zones along the Wash in the reach above the ponds contains 3.9 to 5.4 TU. To the west, the first wells showing increased tritium are in the vicinity of Duck Creek. Well LG030, at a depth of 30 feet, has 47.1 TU whereas an adjacent flowing well (LG029) completed in the low yield sediments at a depth of 97 feet contains 3.9 TU. Thus, water discharging from depth and upgradient of the ponds, contains essentially background tritium concentration and is unaffected by industrial wastes. In the vicinity of the lower ponds, two deep wells (LG017, 019) contain background levels of tritium, which may signify that contamination in the less permeable, deeper sediments has not yet reached the Wash.

Industrial effluents entering the Wash transform the underflow of the Wash from older, largely natural water discharging from the Valley, to one which is predominantly young and from the Colorado River. Water from wells LG006, LG007, and LG055, in or near the Wash channel and downgradient from the ponds, contains 250 to 407 TU.

Tritium concentrations in 23 shallow ground-water sampling points just tapping the water table beneath urban and suburban portions of the Valley also indicate that return flows are present. As expected, concentrations are higher in the eastern half of the developed area where Colorado River water, in various degrees of dilution with ground water, has been delivered since 1955 (see Table 18 and Figure 53). Heaviest use of Lake Mead water has been along Boulder Highway and surrounding areas and in the downtown area (in order, pressure zones 1810, 1845, 1960, 2055, and 2168). Shallow wells purposely located within or adjacent to irrigated areas average 54.7 TU whereas springs, seeps and underdrains sampled regardless of location contain 45.4 TU.

It is apparent from the tritium data (Table 18) that recent recharge has occurred in the urban and suburban areas. Markedly elevated values of 125 and 166 TU characterize return flows in the downtown area and a residential development adjacent to Boulder Highway. Both areas received Lake Mead water in the summer months from 1955-1971. Very shallow ground water beneath Winterwood Golf Course, which is irrigated with treated sewage effluent from the County Plant, contains 24.7 TU and is therefore low but of similar magnitude to other locations known to be irrigated with the same effleunt (e.g., LW015) or receiving Colorado River water (e.g., LW059, 087, 088; LG098, 100, 102, 105, 107). Station LW015 (a spring) contains 38.7 TU and 17.7 mg/ℓ nitrate. The probable source for the discharge of 18.8 gallons per minute (0.083 acre feet per day) is irrigation return flow from Paradise Valley Country Club. For the last 14 years, the course has mainly been watered with effluent from the Clark County Sewage Treatment Plant. Spring flow in Flamingo Wash (LW009, 060) may be recharged in part by return flows of

TABLE 18. TRITIUM CONTENT OF SHALLOW GROUND-WATER RECHARGED BY IRRIGATION RETURN FLOWS FROM URBAN AND SUBURBAN DEVELOPMENTS

Sampling Point	Tritium Content (TU)	Nearby source of recharge	Year(s) developed
LW 009	21.9	Suburban developments and golf courses*	-
015	28.7	Paradise Valley Country Club	1960
059	40.6	Flamingo Reservoir (contains Colorado River water); Paradise Crest Housing tract (served by Colorado River water)	
060	23.7	Flamingo Wash underflow*	
084	35.6	Stardust Country Club Golf Course	
085	22.6	Downtown Las Vegas	Pre-1943
086	13.3	"	Pre-1943
087	98.9	Housing tract	
088	41.1	None†	
089	125	Downtown Las Vegas	Pre-1943
090	25.4	Desert Inn Country Club Golf Course; Convention Center	
092	21.1	Sahara Hotel; nearby homes and businesses	
094	91.8	None†	
LG 098	17	Housing tract	1965-1969
099	24.7	Winterwood Golf Course	1965
100	30.9	Housing tract	1947
101	166	Housing tract	1965
102	53	Huntridge Park homes	Pre-1943
103	45	Housing tract	
104	40.1	Desert Inn Country Club Golf Course	
105	79.1	Royal Crest Rancheros homes	1965
107	36	Southgate homes	1963
130	55.5	Flamingo Wash drain ditch	

* Stations LW084, 009 and 060 (in downstream order) are situated on Flamingo Wash which is the locus of springs and flowing wells and irrigation return flow from nearby golf courses and housing tracts.

† Ground-water discharge from an underdrain in the basement of a department store. Nearby recharge sources include return flow from housing tracts, apartment houses and on-site landscaping.

Colorado River water in that upgradient service areas are pressure zones 2168 and 2055.

Four samples of shallow ground water from observation wells just tapping the water table in areas west of Interstate Highway-15 and adjacent to residential development contain between 9.7 and 38.8 TU. The lowest concentration occurs in perched water at a depth of five feet beneath the Eastland Heights residential area. This development is served by private water supply wells and septic tank systems. Well LG108 with 16.4 TU is adjacent to a development served almost solely with deep ground water. Therefore, local recharge of runoff is believed to be the source of tritium. The maximum value of 38.8 TU is from a well immediately downgradient from the Charleston Estates development which was on ground water until 1972. The elevated tritium is indicative of either very rapid introduction of Colorado River water to return flows or it is a result of precipitation and infiltration of overland flow.

Ground-water seepage at the intersection of the Union Pacific Railroad and Bonanza Road (LW096) contains 38.3 TU compared to 9.5 TU in another seep (LW095) at the junction of Lake Mead Boulevard and Interstate Highway-15. Both sampling points are in or immediately adjacent to the 2168 pressure zone of the Las Vegas Valley Water District; therefore, Lake Mead water mixed with ground water has been present since 1955. There is very light residential development in the surrounding area and minimal lawn watering.

In summary, the tritium data are indicators of in-valley recharge to the shallow ground-water zone. Usefulness as a quantitative tool to determine volume of recharge is generally not possible due to uncertainties with respect to dilution, initial tritium concentrations, and timing of infiltration. Qualitatively, the tritium results corroborate conclusions reached using gross chemical analyses and water budget methods. More intensive tritium sampling would be necessary to define tritium content of shallow ground water completely removed from return flow sources or natural runoff infiltration, and to establish the importance of in-valley recharge from precipitation, concentrated runoff, and localized flooding. Data developed indicate that concentrations of greater than 20 TU are likely a result of irrigation return flows. The utility of using environmental tritium for detailed studies of recharge will decrease with time because environmental tritium concentrations continue to decrease due to termination of the atmospheric thermonuclear testing. Also, radioactive decay is gradually lowering concentrations in shallow ground water to marginally significant concentrations.

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Appendix 1. Characteristics of Selected Observation Wells

SYSTEM FOR LOCATING DATA POINTS AND AREAS

Data points referred to in this report are identified or located by township, range, and section according to the rectangular subdivision of the public lands. Locations are south of the Mount Diablo base line and east of the Mount Diablo meridian. The three-part system used to locate a data point consists of 1) the township (T) south (S) of the base line, 2) the range (R) east (E) of the meridian, and 3) the section number. The section number is followed by letters that indicate the quarter section, quarter-quarter section, and so on. The letters a, b, c, d or the numbers 1, 2, 3, 4 are used to designate the northeast, northwest, southwest, and southeast quarters, respectively. The form incorporating letter characters is more familiar to the general user, whereas the form employing only digits is more readily adaptable to computerized data handling techniques. The systems are interchangeable and both are used herein, as appropriate.

A data point can be located to an area as small as 10 acres insofar as a quarter section is 160 acres, a quarter-quarter section is 40 acres, and a quarter-quarter-quarter section is 10 acres. For example, a well in the SW¼ NW¼NE¼ section 7, T.20S., R.60E. is designated 20/60-07abc or 20/60-07123. If the data point location were only known to within 40 acres, it would be identified as 20/60-0712. A fourth digit may be used to sequentially identify up to nine sampling points in a given 10-acre area but this digit has no location significance. To eliminate confusion, two digits are always used to indicate the section involved. Thus, section seven is indicated as 07.

In addition to the system described, sampling points were also located according to latitude and longitude down to degree, minutes and seconds (Appendix 2).

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
LG001	23/61-04dad1				not logged	
002	22/62-01cba1				"	
003	22/62-08cbd1				"	
004	21/63-14dbd1	48/48		0-48	peak and muck; with sand and gravel, coarse	3.35/27/17/10
005	21/63-14dbd2	100/100		0-100	silt, reddish-brown; with sand and gravel (40)* coarse-medium grain, quartz, sandstone, feldspars, volcanics and limestone	7.06/48/17/48
006	21/63-28aca1	44/44	41-43	0-36	sand and gravel, fine grain, volcanic	2.43/42/16/32
				36-44	gravel, cemented; with igneous fragments; 2' - 3' weathered zone	
007	21/63-28aca2	135/125	90-95	0-20	sand and gravel, fine, volcanic	
				20-37	sand, fine and pea gravel	
				37-40	sand, coarse, volcanic	
				40-48	sand, medium-fine, volcanic	
				48-55	sand, fine, volcanic	
				55-65	sand and gravel, fine, volcanic	
				65-78	gravel, pea, and very coarse; volcanics with conglomerate of volcanic fragments	
				78-120	silt, very clayey, dark reddish-brown	
				120-135	siltstone(?), brown and green, well indurated	
008	21/63-30dad1	34/34	0-34		not logged	
009	21/63-29ccb1	91/91	85-90	0-35	gravel, medium-fine, volcanic, with sand (15) coarse, volcanic, gypsum	
				35-45	sand, coarse, volcanic; with gravel (10) medium, volcanic	
				45-50	silt, with sand (20) fine	
				50-54	gravel, medium, volcanic	
				54-63	sand, coarse, volcanic	
				63-69	sand, coarse, volcanic; with clay (40) reddish-brown	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
				69-73	clay, cream	
				73-91	clay, blue; with gypsum	5.46/80/17/75
LG010	21/63-29ccb2	42/42		0-35	sand and gravel, medium-fine; volcanic; with gypsum	
				35-42	sand, coarse, volcanic	
011†	21/63-29ccd1	39/39	0-39		not logged	
012†	21/63-29ccd2	38/38			"	
013	22/63-05cbb1	250/244	241-243	0-35	gravel, volcanic; with sand, coarse-medium, volcanic	
				35-50	sand, fine-medium; with gravel (20) medium, volcanic	35.6/45/36/43
				50-53	sand, fine-medium; with silt (25)	
				53-55	clay, beige, silty	
				55-57	sand, coarse, volcanic; with clay, brown, with manganese stain	
				57-60	clay, brown, silty	
				60-65	clay, brown, silty; with clay, white	
				65-80	clay, reddish-brown, silty	
				80-84	clay, light brown, silty	
				84-102	clay, beige, silty; with clay, light green with manganese stain	36.8/90/17/69
				102-126	clay, cream	37.8/105/17/95
				126-130	clay, beige and light green, gpysiferous	
				130-165	clay, beige, gypsiferous	
				165-172	clay, bluish-green	36.8/165/17/115
				172-190	clay, brown, gypsiferous	
				190-220	clay, dark brown, gypsiferous	48.5/220/19/170
				220-250	clay, blue, gypsiferous	38.9/250/16/234
014	22/63-05cbb2	45/45	44-45	0-35	sand and gravel, volcanic	
				35-45	sand, fine-medium, volcanic; with gravel (20) medium volcanic	35.6/45/36/43

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
015	21/63-30cbcl	25/25	23-25	0-22	sand and gravel with fragments of limestone, chert and dolomite	
				22-25	gravel, medium, beige; with fine sand (20); both composed of limestone, chert and dolomite	
016	21/63-30cbc2	47/47	43-46	0-24	sand, fine, beige; with gravel coarse, composed of chert, gray limestone and dolomite	
				24-29	sand, fine, beige, composed of limestone, chert and dolomite	
				29-43	clay, greenish-gray; with (10) sand, fine	
				43-47	clay, cream and blue-gray	
017	21/63-31abbl	90/83	80-82	0-11	gravel, coarse; with sand and pebbles of rhyolite, scoria, basalt and some chalcedony quartz	5.8/11/17/10
				11-18	gravel and sand, coarse, composed of scoria, basalt, rhyolite	
				18-22	sand, fine	
				22-45	sand, fine-medium	5.6/82/ 2/43
				45-87	not logged	
				87-90	clay, green	69.43/83/21/82
018‡	21/63-31abb2	20/20	1-20	0-0.5	sand, gray-light brown, gravelly	
				0.5-1	sand, brown	
				1-3	sand, light brown	
				3-7.5	sand, light brown, silty	
				7.5-16.5	sand, brown, gravelly	
				16.5-20	gravel, gray-brown, sandy	
019	21/63-31babl	70/68		0-20	sand and clay, fine, brown; with gravel (5) volcanic	
				20-30	sand and clay, fine, gray	
				30-34	sand, fine, gray, volcanic	4.40/34/1.5/20
				34-38	clay, gray, sandy; with gravel medium, volcanic	
				38-45	gravel, medium-coarse; with sand, coarse, volcanic	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)/Total Depth (feet)/Shut Down (hours)/Casing String (feet)
				45-57	clay, cream	
				57-62	clay, buff green, very adhesive	
				62-70	clay, blue	flowing
020	21/63-31bab2	20/18		0-20	sand, fine; with some clay	4.11/20/2/17.5
						4.07/20/17.5/17.5
021	21/63-31cca1	40/40	37-39	0-10	alluvium, disturbed	
				10-17	not logged	
				17-20	gravel, coarse, brown, composed of scoria, basalt, and chalcedony quartz; with medium sand (15)	
				20-27	sand, coarse-fine, brown; with clay (15)	
				27-30	clay, brown, sandy; with gravel, fine, (15) composed of scoria, basalt, etc.	
				30-40	clay, hard, pinkish-brown with some manganese stain; with clay, plastic, green	
022‡	21/63-31cca2	22	1-22	0-20	sand, brown, silty	
				20-22	sand, red-brown, silty	
023	22/63-06dba1	45/45	43-44	0-35	sand and gravel, volcanic	
				35-45	silt and gravel	
024†	22/63-06dba2	30/30	1-30	0-0.5	salts, evaporative	
				0.5-1	transitional	
				1-2	sand, brown	
				2-6	sand, red-brown, gravelly	
				6-9	sand, light red-brown, silty	
				9-10	sand, red-brown, gravelly	
				10-11.5	sand, light red-brown	
				11.5-30	sand, red-brown, gravelly	
025	21/63-07bcb2	24/24		0-24	sand and gravel, fine-medium, reddish, volcanic	
						11.4/21/41/10
026	21/63-07bcb1	100/91	87-90	0-37	sand and gravel, fine-medium, reddish	
				37-42	sand and clay, fine, maroon; with gravel (10) medium, volcanic	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
				42-25	gravel, coarse, volcanic; with sand, medium grain	
				45-58	sand, fine, volcanic; with gravel, (5) coarse	
				58-90	clay, brown silty	19.5/83/17/67
				90-93	sand and gravel, fine	
				93-100	clay, brown; with sand (10) coarse grain	
027	21/62-36baa1	62/62	57-62	0-13	not logged	7.95/13/ -/0
				13-25	sand and gravel, coarse, volcanic, intermixed with cobbles	6.98/26/41/16
				25-55	sand, medium, volcanic	6.16/45/17/32
				55-62	siltstone, reddish-brown, sandy	5.6 /62/17/62
028‡	21/63-36baa2	20/20	1-20	0-1	sand, light brown, silty	
				1-5	sand, brown, gravelly	
				5-14	sand, light brown, gravelly	
				14-20	sand, brown, gravelly	
029	21/62-26dba1	100/100	95-100	0-23	sand and gravel, medium-coarse, light gray, volcanic	7.17/15/20/11 5.79/23/0.5/11
				23-30	sand, very fine, tan; with clay	
				30-34	sand, very fine, volcanic	
				34-42	gravel, medium, volcanic	4.83/34/17/34
				42-100	siltstone, reddish-brown, sandy; with gravel (10) fine, volcanic	1.17/100/17/38
030	21/62-26dba2	30/30	27-29	0-23	gravel and sand, coarse, volcanic	
				23-30	sand and gravel, volcanic	5.28/30/17/30
031	22/62-11cbb1	63/63	47-62	0-30	gravel, medium, volcanic; with sand (10) medium-fine, volcanic	
				30-38	gravel, medium-fine, volcanic; with sand and silt (20)	
				38-63	silt; with sand (25), coarse	36.7/63/17/35
032	22/62-11dac1	155/147		0-68	sand and gravel, volcanic	38.1/41.6/17/40

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
						40.04/47/18/45
						36.75/62.5/0.5/54
				68-105	sand, coarse, volcanic; with pea gravel (5)	38.2/10/19/80
				105-120	silt, beige, sandy	
				120-150	gravel and sand, calcified	36.5/150/5.5/143
						35.0/150/17/143
033	22/62-11dac2	45/40	36-39	0-45	sand and gravel, volcanic	36.0/45/17/40
034†	21/62-15dda1	35/35	0-35		not logged	
035	21/62-15dda2	105/105	100-104	0-10	sand, fine-coarse, volcanic, construction fill dirt	
				10-50	clay, tan-beige, sandy; with gravel (20) coarse, composed of limestone, chert and dolomite	
				50-70	clay, light tan	
				70-80	clay, greenish-gray with manganese stain	
				80-85	clay, cream, light green, with some manganese stain	
				85-105	clay, reddish-brown; with fine sand (15), Muddy Creek Formation?	
036	21/62-22bda1	50/50	44-49	0-45	siltstone, beige, sandy; with gravel (10) medium, limestone	
				45-50	clay, cream	7.94/50/3/15
037†	21/62-22bda2	31/31	29-31	0-31	siltstone, beige, sandy	
038	22/62-04bdb1	112/93	90-92	0-2	sand, coarse, loose	
				2-3	caliche	
				3-7	gravel, light gray, composed of fragments of basalt, scoria, and trachyte	
				7-18	siltstone, reddish-brown, sandy; with gravel (10) fine, volcanic	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
				18-20	conglomerate, tan to gray, composed of clasts of basalt, scoria, chert and dacite	4.04/20/39/5
				20-30	siltstone, tan, sandy; with fragments of basalt, scoria and trachyte	
				30-35	conglomerate and siltstone, grayish-tan	
				35-45	siltstone, reddish-brown, sandy	
				45-50	siltstone, reddish-tan, sandy	
				50-56	siltstone, light chocolate-brown	
				56-63	siltstone, brown, sandy	
				63-74	siltstone, beige, sandy	
				74-80	siltstone and conglomerate, gray-brown, sandy	
				80-86	siltstone, tan, sandy	
				86-97	siltstone and conglomerate, grayish-tan, sandy	
				97-112	siltstone, tan, sandy	4.21/112/17/90
039	22/62-04bab2	40/40		0-20	siltstone, beige, sandy; with conglomerate, gray, intraformational	
				20-28	siltstone, brownish-gray, sandy; with conglomerate, gray, intraformational	
				28-33	siltstone, beige, sandy	
				33-40	siltstone, brown, sandy; with conglomerate, intraformational	
040	22/62-04bcb3	110/101	98-100	1-16	siltstone, tan, sandy; with gravel (15) composed of pebbles of limestone, basalt and scoria	
				16-17.5	sandstone, brown, cemented by calcite	
				17.5-22	siltstone, tan, sandy, same as 0-16 interval	
				22-28	sandstone and conglomerate, light gray; with gravel (15) volcanic	
				28-37	siltstone, brown, sandy	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
				37-43	sandstone and conglomerate, light gray	
				43-59	siltstone, brown, sandy	
				59-70	siltstone, gray, sandy; with silt (50), sandy (50)	
				70-110	siltstone, brown-tan	6.50/85/20/40
041	20/62-32aba1	67/67	61-64	0-35	silt and gravel, light gray, sandy	
				35-37	caliche	
				37-42	silt and gravel, light gray, sandy	
				42-57	silt, light beige, sandy	
				57-60	silt, light green, sandy	
				60-67	clay or silt, cream and beige, sandy	
042	20/62-32aba2	170/170	159-169	0-41	silt, light gray, sandy; with gravel, coarse	
				41-63	silt, light beige, sandy	
				63-80	clay, cream; with clay, beige	
				80-108	silt, beige, sandy	
				108-126	silt, cream, sandy	
				126-137	silt, light beige, sandy	
				137-148	silt, white, sandy	
				148-157	silt, tan, sandy	
				157-170	silt, beige, sandy	
043	21/62-29dcd1	56/56	46-56	0-25	siltstone, tan, sandy; with pea gravel (10)	
				25-28	siltstone, beige, sandy	
				28-29	sandstone, reddish-brown, intraformational, cemented	
				29-35	siltstone, beige, sandy	
				35-42	siltstone, light pinkish-brown, sandy; with sand, (35) coarse grain	
				42-56	siltstone, beige, sandy; with gravel (10), medium	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum) Total Depth (feet) Shut Down (hours) Casing String (feet)
044	21/62-29dcd2	129/129	122-125	0-37	silt, beige, sandy	
				37-40	silt, beige, sandy; with sand, coarse, volcanic	
				40-42	sand and gravel, pinkish-beige, well cemented	
				42-55	silt, pinkish-brown, sandy; with sand (30), coarse, volcanic	
				55-60	silt, beige, sandy	
				60-67	silt, light chocolate brown, sandy	
				67-75	silt, tan, sandy; with sand and gravel (10) coarse	
				75-90	silt, grayish brown	
				90-129	silt, pinkish-tan	
045	21/62-19aaa	125/125	122-125	0-15	silt, beige, sandy; with caliche	
				15-37	silt, light chocolate brown, sandy	
				37-48	silt, pinkish-brown, sandy; with gravel (15)	
				48-55	silt, chocolate brown, sandy	
				55-70	silt, pinkish-brown, sandy	
				70-125	silt, chocolate brown, sandy	28.45/125/41/125
046	21/62-19aaa2	40/40	36-39	0-15	silt, beige, sandy; with caliche	
				15-37	silt, light chocolate brown, sandy	
				37-40	silt, pinkish-brown, sandy; with sand and gravel (15)	
047	20/61-36ddd1	100/100	96-99	0-19	silt, beige, sandy; with pebbles limestone	
				19-63	silt, pinkish-tan	14.06/45/17/40
				63-65	anhydrite(?), light gray, sugary	
				65-70	silt, pinkish-tan	
				70-81	anhydrite(?), light gray, sugary	
				81-93	silt, pinkish-tan	
				93-100	silt, beige, sandy	
048	20/61-36ddd2	40/40	36-39	0-19	silt, beige, sandy	
				19-40	silt, pinkish-tan	

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
049	21/63-29ccb3	35/35	0-35		not logged				
050	21/62-35dda1	20/20	0-20		"				
055†	21/63-29ccb4	30/30	0-30		"				
056	21/62-11bcb1				"				
057	20/61-03dab1				log available from Division of Water Resources (DWR)				
058	20/61-15dcc1				"				
059	20/61-29ccc1				not logged				
060	21/62-22bbd2	20/20§			log available from DWR				
061	19/60-04cda1	706/631	531-631		"				
062	19/60-09cda1	612/			"				
063	20/61-36bbb1	300/	none		"				
064	20/62-18bbc1	300/	55-120		"				
065	20/62-08aba1	120/	70-115		"				
066	20/61-03dab1	350/			"				
067	20/61-20caa1	570/	394-570		"				
068	20/61-20caa1	75/	none		"				
069	20/61-20cab	400/			"				
070	20/61-28cda1	440/			"				
071	21/61-04baa1	400/			"				
072	20/61-33ccb1	425/			not logged				
073	20/61-33cca1	400/400	270-400		log available from DWR				
074	20/61-34bcb1	780/757	280-290		"				
075	21/61-01bba1	400/200			"				
076	21/62-29ccc1	404/			"				
077	21/61-24aad1	160/160	60-160		"				
078	21/61-24aad1	100/100			"				
079	21/61-25cac1				not logged				
080	22/61-03dda1	335/	none		log available from DWR				
081	22/61-01dac1	209/			"				
082	21/62-30dbb1	390/			"				

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
083	21/62-03cabl	200/			log available from DWR				
084					"				
093					not logged				
098	21/62-08dcal	25/24	23-24	0-2	silt, sandy				
				2-3	soil, organic				
				3-4.5	caliche				
				4.5-8	clay, sandy				
				8-11	silt, clayey				
				11-12	sand				
				12-14	clay				
				14-14.5	sandϕ				
				14.5-17	clay				
				17-17.5	sandϕ				
				17.5-21	clay				
				21-25	sandϕ				
099	21/62-09abal	26/25	24-25	0-1	clay, silty				
				1-3.5	sand, silty				
				3.5-5	clay				
				5-18	sand, silty				
				18-20.5	gravel, sandy, calcareous				
				20.5-26	sandϕ				
100	20/61-35adal	12/11	10-11	0-2.5	fill				
				2.5-7	clay, silty				
				7-8	sand, medium				
				8-8.5	clay, silty				
				8.5-11	sandϕ				
				11-12	clay, sandy				
101	21/62-21cdal	31/30	29-30	0-5	sand, silty, grading downward to sandy silt with calcareous gravel				
				5-11.5	clay, gypsiferous in upper portion				
				11.5-14	clay, sandy with caliche gravel				

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
				14-15.5	clay, gypsiferous				
				15.5-26.5	clay, sandy				
				26.5-27	caliche				
				27-28	clay, silty				
				28-30.5	sand, siltyϕ				
				30.5-31	clay, silty, with caliche gravel				
102	21/61-02bac1	20/17	16-17	0-4	clay				
				4-9	clay with interbedded caliche gravel				
				9-11.5	clay, sandy				
				11.5-14.5	sand with calcareous gravel				
				14.5-15	clay and calcareous gravel				
				15-16	sandϕ				
				16-20	clay, sandy				
103	21/61-01cac1	10/9	8-9	0-4.5	silt				
				4.5-7.5	clay, silty, with coarse calcareous gravel				
				7.5-10	clay, silty, with gravelϕ				
104	21/61-13bbc1	8/7	6-7	0-3	sand, silty				
				3-3.5	clay, silty, with gravel, calcareous				
				3.5-6	clay, silty				
				6-8	clay, with calcareous gravelϕ				
105	21/61-23dab1	36/35	34-35	0-5.5	sand, silty				
				5.5-11.5	silt, sandy				
				11.5-20	clay, with calcareous gravel				
				20-23	clay				
				23-25.5	sandϕ				
				25.5-26	clay				
				26-27	sandϕ				
				27-28	clay				
				28-28.5	sandϕ				
				28.5-33	clay				
				33-34	sandϕ				
				34-36	clay				

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
106	22/61-02bba1	46/45	44-45	0-1	sand				
				1-4	silt, sandy				
				4-7.5	caliche				
				7.5-10	silt, sandy				
				10-13	caliche				
				13-17	caliche, friable				
				17-19.5	caliche				
				19.5-33	clay				
				33-34	caliche				
				34-38	clay				
				38-43	clay, silty, with calcareous gravelϕ				
				43-46	clay, sandy				
107	21/61-26ccb1	31/30	29-30	0-2	silt, sandy				
				2-7.5	caliche conglomerate				
				7.5-9.5	silt, sandy				
				9.5-10	caliche				
				10-27	clay				
				27-31	clay, silty with 6 to 8 inch thick sand and gravel lensesϕ				
108	21/61-09acd1	36/35	34-35	0-1.5	fill				
				1.5-4	silt, sandy, gypsiferous				
				4-6	gravel, calcareous				
				6-11	caliche conglomerate				
				11-19.5	silt, sandy, with calcareous gravel				
				19.5-22.5	clay				
				22.5-26	limestone conglomerate				
				26-30	silt, sandy, with calcareous gravelϕ				
109	21/61-05cbc1	39/37	36-37	0-8.5	silt, sandy, with caliche gravel				
				8.5-10	caliche				
				10-14.5	sand, silty, with calcareous gravel				
				14.5-17	clay, silty				

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
				17-21	sand, silty with caliche and gravel				
				21-24.5	clay, silty				
				24.5-26	sand, silty, with calcareous gravel				
				26-29.5	clay, silty, with calcareous gravel				
				29.5-34	calcareous gravel				
				34-35	clay, sandy				
				35-36.5	caliche				
				36.5-39	gravel, calcareousϕ				
				39-	caliche				
110	20/61-33cdbl	35/21	20-21	0-9	silt, sandy				
				9-14.5	silt with calcareous gravel				
				14.5-17	caliche conglomerate				
				17-21.5	gravel, calcareousϕ				
				21.5-28	clay, gravelly				
				28-34	clay, silty, with calcareous gravel				
				34-35	silt, gravelly				
111	21/62-22bba				not logged				
112	20/60-24aaa	312/312	213-312		log available from DWR				
113	19/60-23bbc	560/			"				
114	19/60-27aab	605/			not logged				
115	20/62-19cab	200/200	none		log available from DWR				
116	20/62-19bbb	289/289			not logged				
117	20/61-13adb	300/300	60-300		log available from DWR				
118	20/62-04add	800/800	70-784		"				
119	20/61-04add	900/900			"				
120	22/61-12bbb				"				
121	20/61-19bba	295/295	275-290		"				
122	20/61-33cca	226/			"				
123	20/61-35cbb	460/			"				
124	21/61-04dacl	650/			"				

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)
125	21/61-04dac2	810/			log available from DWR				
126	20/61-18bcc	500/500	300-500		"				
127	20/61-29cbc	600/			"				
128	21/62-15ccb	30/30	0-30		not logged				
129	20/61-30ddb	10/10	8-10		"				
130	21/62-08aad	90/			log available from DWR				
131	19/60-23add	90/			"				
132	20/60-19dca	5/5			not logged				
133	20/61-31aba1	91/90	86-90	0-6	caliche, hard, dense				
				6-37.5	not logged				
				37.5-46.5	caliche, medium-hard, slightly cemented				
				46.5-49.5	clay, silty, calcareous, interbedded thin caliche gravel				
				49.5-52	caliche, hard, dense				
				52-58	clay				
				58-59	caliche				
				59-87	clay, interbedded with thin lenses of caliche				
				87-88.5	caliche				
				88.5-91	clay				
134	21/61-31aba2	20/19	17-19	0-20	same as log for LG133				
135	20/62-21cda1	215/			log available from DWR				
136	21/62-08dca1	100/			"				
137	21/61-12cdb	375/			"				
138	21/61-10add1	6/			not logged				
139†	20/60-19dbb1	17/			"				
140	19/60-23aab1	208/			log available from DWR				

* Percent present in cuttings sample.

† Dewatering well installed by the A & K Construction Co. in conjunction with installation of the Southern Nevada Water Project pipeline. Cased to full depth of drilled hole with continuously slotted 20-inch diameter pipe.

Appendix 1 (continued)

Well	Location	Depth drilled/ depth cased (feet)	Perforated Interval (feet)	Depth (feet)	Description	S.W.L. (feet below datum)	Total Depth (feet)	Shut Down (hours)	Casing String (feet)

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‡ Observation well installed by Montgomery Engineers of Nevada, Inc. for BMI. Cased to full depth with continuously slotted 2-inch diameter pipe.

ɸ Water bearing.

§ Estimated.

Appendix 2. Location and Description of Water Sampling Stations

ABBREVIATIONS USED IN APPENDIX 2

ADJ - adjacent
AK - A & K Construction Company
AP - airport
ARTES - artesian
B - Boulder
BC - Boulder City
BLDR - Boulder
BMI - Basic Management, Inc.
BTN - between
CC - country club
CCSTP - Clark County Sewage Treatment Plant
CEN - central
CHRAL - Charleston
COMP - complete
CONV CNTR - Convention Center
COR - corner
CORTZ - Cortez
CROSS - crossing
CRS - course
CURT MAN - Curtis Manor
CUT - cutthroat (flume)
CYP - Cypress
DEPT - department
DISC - discountinued
DRI - Desert Research Institute
E - east
EFFL - effluent
EMRSN - Emerson
ESTERN - Eastern
EXPWY - expressway
FLAM - Flamingo
FRWY - freeway
GC - golf course
HARRS - Harris
HEND - Henderson
HO - hotel
HWY - highway
INFL - influent
L - lake
LC - lower crossing of Las Vegas Wash and SNWP
LIQ - liquid
LM - Lake Mead
LN - Lane
LOW - lower
LT - lot
LV - Las Vegas
LVBM - Las Vegas Building Materials
LVBN - Las Vegas Blvd. North
LVVWD - Las Vegas Valley Water District
LVW - Las Vegas Wash
MAT - material
MONT WARD - Montgomery Ward
MRLND - Maryland
N - north
ND - and
NLV - North Las Vegas
NO - number
OGD - Ogden
OKY - Oakey
OUTFL - outfall
P HOL ADAIR - Pot Holiday Authority (Carlton Adair)
PRKNG - parking
PRWY - Parkway
RES - resvoir
RS - rock/sand
S - south
SAND - Sandhill
SHRA - Sahara
SNWP - Southern Nevada Water Project
SP - spring
STA - station
STP - sewage treatment plant
SUP - supper
SW - southwest
TERM - terminal
TIMET - Titanium Metals Corporation
TL and PRDS - Telephone Line (Hollywood Blvd.) and Pabco Roads
TR PK - trailer park
TRIB - tributary
UP - upper
UPRR - Union Pacific Railroad
V - valley
VEHCLS - vehicles
VV - Valley View
W - West
WINTRWD, WW - Winterwood
WY - way

EXPLANATION OF SAMPLING LOCATIONS

DESIGNATION OF SAMPLING LOCATIONS (S. P. Designation)

The following conventions were employed in numbering sample location and containers:

Type Sampling Point	Designation
Surface water in Las Vegas Valley	LW & 3 digit number commencing with 001
Ground water	LG & 3 digit number commencing with 001

Surface water is defined in the present study to include all samples collected from other than wells. The designation of LG (ground water) points is therefore restricted to locations where the sample is removed directly from the subsurface. Springs, seeps, ground-water fed streams and various wastewater discharge points are classified as surface water (LW) and further subdivided according to type.

SAMPLE POINT INDEX (S. P. Index)

Code	Sample Point
1	Stream, river, creek
2	Lake, pond, reservoir
3	Well
4	Precipitation
5	Spring
6	Mine
7	Cave
8	Composite
9	Ditch
0	Other or unknown
A	Sanitary waste (occurs as surface water)
B	Industrial waste (occurs as surface water)
C	Industrial wastes mixed with ground water (occurs as ground water)
D	Industrial wastes mixed with ground water (occurs as surface water)
E	Power plant cooling and blowdown water discharge
F	Liquid fraction of sewage sludge

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
21/62-232311	1	LW001	LAS VEGAS WASH 1	360638	1150131
21/62-234241	1	002	LAS VEGAS WASH 2	360614	1150059
21/63-303411	1	003	LAS VEGAS WASH 3	360518	1145901
21/63-293241	1	004	LAS VEGAS WASH 4	360521	1145825
21/63-293311	1	005	LAS VEGAS WASH 5	360524	1145810
21/63-281121	1	006	LAS VEGAS WASH 6	360556	1145629
21/63-144111	1	007	LAS VEGAS WASH 7	360720	1145416
21/61-131221	1	008	FLAMINGO WASH 1	360745	1150626
21/61-131211	1	009	FLAMINGO WASH 2	360747	1150624
21/62-314111	5	010	STEVENS SPRING	360437	1150445
21/62-294343	5	011	UNNAMED SPRING	360513	1150412
21/62-294221	5	012	GRAPEVINE SPRING	360530	1150418
22/62-051411	5	013	WHIT. MESA SP. 1	360358	1150353
22/62-043221	5	014	WHIT. MESA SP. 2	360314	1150348
22/62-042331	5	015	WHITNEY MESA SEEP	360353	1150346
21/62-273421	A	016	CLARK STA OUTFALL	360518	1150226
22/62-114131	B	017	STAUFFER DITCH A	360244	1150051
22/62-021431	B	018	STAUFFER DITCH B	360351	1150056
21/62-354141	C	019	LV BLDG MAT POND	360431	1150046
21/62-363441	C	020	HEND STP GW DRAIN	360421	1150010
21/62-363411	A	021	HEND STP OUTFALL	360427	1150010
22/63-072311	B	022	TITANIUM DITCH	360308	1145926
22/63-071221	A	023	BMI STP OUTFALL	360316	1145854
21/62-113231	B	025	NEV RS DISCHARGE	360810	1150141
21/62-104221	E	026	SUNRISE STA OUTFALL	360813	1150206
21/62-222241	A	027	CLARK COUNTY STP EFFL	360646	1150236
21/63-313131	C	028	BMI SEEP PABCO-RD	360440	1145916
21/63-293325	D	029	GRAVEL PIT DRAIN	360519	1145824
21/63-281421	2	LW030	POND ADJ LV WASH	360546	1145632

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
20/61-363431	1	LW031	CHARLESTON DITCH	360934	1150630
21/63-322341	C	032	GRAVEL PIT SEEP	360453	1145825
21/62-224421	1	033	TRIB TO DUCK CREEK	360610	1150154
21/62-103441	A	034	LV STP OUTFALL	360748	1150218
22/62-021441	B	035	BMI NO. 1 (disc.)	360352	1150046
22/62-024321	D	039	GRAVEL PIT	360303	1150106
21/63-304311	1	041	LAS VEGAS WASH 9	360518	1145850
22/62-123231	B	042	STAUFFER EFFL 3	360247	1150032
22/62-123321	B	043	STAUFFER EFFL 6	360243	1150031
22/62-123232	B	044	STAUFFER EFFL 2	360246	1150039
21/63-304312	1	045	LAS VEGAS WASH 9A	360516	1145856
21/63-312241	D	047	BMI POND SEEP 1	360459	1145922
21/63-312211	D	048	BMI POND SEEP 2	360507	1145924
21/63-312221	D	049	BMI POND SEEP 3	360511	1145928
20/62-302431	1	050	E. WASH AVE DITCH	361052	1150532
21/62-102331	1	051	WINTRWD GC STREAM	360757	1150245
21/62-354131	D	052	LVBM USED WATER	360427	1150043
21/62-103442	F	053	LVSTP SLUDGE LIQ	360748	1150114
21/62-344431	2	054	LVBM NEW POND	360422	1150149
22/62-123241	B	055	STAUFFER CUT FLUME	360245	1150028
17/59-341121	5	057	CORN CREEK SPRING	362620	1152120
22/58-023321	5	058	BONNIE SPRINGS	360312	1152712
21/62-191113	5	059	FLAM RES COMP GW	360653	1150457
21/61-124131	5	060	FLAM WASH 3	360810	1150611
21/62-103421	A	061	LVSTP INFL	360840	1150225
21/62-222221	A	062	CLARK CO STP INFL	360718	1150243
21/63-293242	1	063	LVW 4 NORTH	360531	1145825
21/62-274341	E	064	DUCK CR AT US 93	360506	1150200
21/63-281313	1	LW065	LVW ABOVE LW030	360545	1145636

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
21/62-363442	A	LW066	HEND STP INFL	360421	1150009
22/63-071111	A	067	BMI STP INFL	360316	1145839
23/64-094311	A	068	BC STP INFL	355803	1144942
23/64-094312	A	069	BC STP EFFL	355758	1144942
21/62-053221	1	070	FLAM WASH AT LAMB	360906	1150451
21/63-313313	D	071	UPPER POND SEEP	360424	1145922
21/61-131231	1	072	FLAM WASH AT EMRSN	360737	1150636
21/63-312222	D	073	NE COR LOW POND	360507	1145926
21/62-191114	5	074	FLAM RES DRAIN 1	360653	1150458
21/62-191115	5	075	FLAM RES DRAIN 2	360652	1150458
21/62-222421	4	076	CCSTP OUTFL FLUME	360643	1150225
21/62-072411	9	077	FLAM WASH AT B HWY	360083	1150543
21/62-092231	9	078	FLAM WASH AT NELLIS	360802	1150322
20/61-263221	9	079	LV CR AT FNSY PARK	361052	1150705
20/61-273431	9	080	LV CR AT MAIN ST	361030	1150621
20/61-294431	9	081	LV CR AT RANCHO	361030	1151029
20/61-312141	9	082	LV CR AT BEDFORD	361015	1151147
21/63-281313	1	083	LVW BELOW LW065	360550	1145641
21/61-14142	5	084	SAHARA-NEV. C. C.	367150	1150717
20/61-263311	5	085	LEROY APTS.	361036	1150749
20/61-263312	5	086	MARYLAND PKWY HARRS	361038	1150750
21/61-02111	5	087	BALLARD ND ESTRN	360930	1150705
21/61-01211	5	088	MONT WARDS	360930	1150647
20/61-34131	5	089	CORTZ PARKING LOT	361005	1150741
21/61-10331	5	090	CONVENTION CENTER	360758	1150904
21/61-20114	5	091	DUNES HOTEL	360647	1150922
21/61-09111	5	092	SAHARA HOTEL	360835	1150922
21/61-14223	5	094	SEARS	360735	1150805
20/61-22421	5	LW095	LM ND FRWY NO 1	361144	1150820

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
20/61-27341	5	LW096	BONANZA ND UPRR	361037	1150833
20/61-31113	2	097	LVVWD 50 MG RES	361019	1151123
20/61-34211	9	098	CASINO CENTER ND OGD 30	361020	1151833
20/62-31341	9	099	DEL AMO ND SAND 9	360941	1150519
20/61-34133	9	100	CEN TELEPHONE BLDG	361005	1150822
23/61-044141	3	LG001	NEW HEND AP WELL	355830	1150922
22/62-013211	3	002	PITTMAN ARTES WELL	360339	1150022
22/62-083241	3	003	PARADISE V CC	360246	1150444
21/63-144241	3	004	P HOL ADAIR 48	360714	1145425
21/63-144242	3	005	P HOL ADAIR 100	360713	1145425
21/63-281311	3	006	OLD USGS GAGE 44	360545	1145634
21/63-281312	3	007	OLD USGS GAGE 135	360644	1145638
21/63-304141	3	008	AK NO 5 LC 35	360526	1145827
21/63-293321	3	009	SNWP LC 91	360520	1145824
21/63-293322	3	010	SNWP LC 42	360519	1145824
21/63-293341	3	011	AK NO 36 LC 39	360517	1145819
21/63-293342	3	012	AK NO 37 LC 38	360517	1145817
22/63-053221	3	013	BMI E UP POND 250	360344	1145825
22/63-053222	3	014	BMI E UP POND 45	360344	1145826
21/63-303231	3	015	TL AND P RDS 25	360527	1145933
21/63-303232	3	016	TL AND P RDS 47	360526	1145933
21/63-311221	3	017	PABCO RD E 90	360506	1145900
21/63-311222	3	018	PABCO RD E 19.5	360506	1145901
21/63-312121	3	019	BMI L POND E 70	360506	1145921
21/63-312122	3	020	BMI L PONDS E 20	360459	1145922
21/63-313311	3	021	L UPPER PONDS 40	360424	1145922
21/63-313312	3	022	L UPPER PONDS 22	360424	1145922
22/62-064211	3	023	BMI W UP POND 45	360345	1145854
22/63-064212	3	LG024	BMI W UP POND 30	360346	1145856

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
21/63-072322	3	LG025	TIMET DITCH 24	360308	1145926
21/63-072321	3	026	TIMET DITCH 100	360307	1145927
21/62-362111	3	027	BMI L PONDS W 62	360506	1150011
21/63-362112	3	028	BMI L PONDS W 19.5	360507	1150011
21/62-264211	3	029	DUCK CK AT LVW 100	360529	1150101
21/62-264212	3	030	DUCK CK AT LVW 30	360529	1150100
22/62-113221	3	031	GIBSON RD 63	360253	1150141
22/62-114131	3	032	STAUFFER DITCH 150	360243	1150050
22/62-114132	3	033	STAUFFER DITCH 45	360245	1150048
21/62-154411	3	034	AK UP CROSS 35	360245	1150047
21/62-154412	3	035	DRI UP CROSS 105	360703	1150149
21/62-222411	3	036	COUNTY STP 50	360640	1150215
21/62-222412	3	037	COUNTY STP 31	360640	1150216
22/62-042321	3	038	WHITNEY MESA 112	360356	1150337
22/62-042322	3	039	WHITNEY MESA 40	360354	1150342
22/62-042323	3	040	WHITNEY MESA 110	360355	1150344
20/62-321211	3	041	UPPER LVW 67	361019	1150407
20/62-321212	3	042	UPPER LVW 170	361020	1150407
21/62-294341	3	043	NO NAME SP 56	360514	1150410
21/62-294342	3	044	NO NAME SP 129	360514	1150411
21/62-191111	3	045	CAMPBELL RES 125	360649	1150500
21/62-191112	3	046	CAMPBELL RES 40	360648	1150500
20/61-364441	3	047	CHARLESTON BLVD 100	360933	1150551
20/61-364442	3	048	CHARLESTON BLVD 40	360933	1150552
21/63-293323	3	049	AK NO 20 LC 35	360520	1150130
21/62-354411	3	050	LVBM WELL WATER 20	360532	1150041
21/63-293231	3	051	AK LC COMP 30	360525	1145826
21/63-293232	3	052	AK LC COMP 30	360524	1145826
21/63-293233	3	LG053	AK LC COMP 30	360522	1145826

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
21/63-293331	3	LG054	AK LC COMP 30	360517	1145824
21/63-293324	3	055	AK NO 16 LC 30	360521	1145825
21/62-112321	3	056	NEV RS WASH WATER	360912	1150206
20/61-034121	3	057	NO 2 NELLIS AFB	361420	1150815
20/61-154331	3	058	NLV LOSEE WELL	361215	1150827
20/61-29333	3	059	NO 34 LVVWD	360946	1151124
21/62-222242	3	060	CCSTP DEWATER	360646	1150231
19/60-04341	3	061	CITY LV, TULE 706	361923	1151607
19/60-09341	3	062	CITY LV, TULE 612	361835	1151613
20/61-36222	3	063	T. H. GEE 325	361025	1150806
20/62-18222	3	064	3115 LVBN 300	361227	1150412
20/62-08121	3	065	4229 LVBN 120	360605	1150551
20/61-03412	3	066	NELLIS AFB 350	361342	1150812
20/61-20311	3	067	3086 W L MEAD 665	361144	1151054
20/61-20311	3	068	3001 W L MEAD 300	361144	1151046
20/61-20312	3	069	226 ANDERSON 400	361141	1151105
20/61-28341	3	070	1531 W BONANZA 440	361036	1150937
21/61-04211	3	071	1823 W CHARL 400	360928	1150957
20/61-33332	3	072	2040 GOLDRING 425	360947	1150900
20/61-33331	3	073	1824 GOLDRING 400	360947	1150957
20/61-34232	3	074	UPRR NO 157, 780	361012	1150905
21/61-01221	3	075	2500 BLDR HWY 400	360926	1150654
21/62-29333	3	076	4200 E RUSSEL 404	360511	1150451
21/61-24114	3	077	3340 ROCHELLE 160	360643	1150606
21/61-24114	3	078	3360 ROCHELLE 100	360643	1150603
21/61-25313	3	079	5326 TOPAZ (was coded as 5360)	360526	1150648
22/61-03441	3	080	7117 PARADISE 335	360338	1150814
22/61-01413	3	LG081	7044 TOMIYASU 101	360345	1150613

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
21/62-30422	3	LG082	5372 SANDHILL 390	360513	1150525
21/62-03312	3	083	6000 E CHARLESTON 200	360857	1150227
21/62-31133	3	084	6100 S PEARL 600	360443	1150524
21/62-30241	3	093	CASEY ND SANDHILL	360536	1150529
21/62-08433	3	098	DILLINGHAM 25	360757	1150412
21/62-09122	3	099	W W GOLF CRS 26	360835	1150935
20/61-35144	3	100	SW 25TH ND ELM 12	361008	1150657
21/62-21314	3	101	BILLMAN 31	360610	1150323
21/61-02213	3	102	STIBOREK 20	360922	1150749
21/61-01434	3	103	MOTOR VEHICLE 10	360855	1150645
21/61-13223	3	104	PETERSON 8	360738	1150700
21/61-23412	3	105	JARRETT 36	360625	1150720
22/61-02221	3	106	ENGELSTAD 46	360416	1150756
21/61-26332	3	107	MCSTRAVIK 31	360522	1150805
21/61-08134	3	108	I15 MILO WY 36	360817	1151040
21/61-05323	3	109	VV AND OKY 39	360830	1151119
20/61-33342	3	110	JOSEPHS 35	360943	1150950
20/60-24111	3	112	CURT MAN #2, 312	361208	1151222
19/60-23223	3	113	7000 GILCREASE 560	361750	1151422
19/60-27112	3	114	RANCH SUP CLUB 605	361313	1151243
20/62-19312	3	115	LA PAZ TR PK 200	361142	1150532
20/62-19222	3	116	2343 N PECOS 289	361209	1150549
20/61-13142	3	117	2934 LVBN 300	361248	1150602
20/62-04144	3	118	NELLIS AFB #1, 800	361430	1150240
20/61-04144	3	119	628 W CRAIG RD 900	361945	1151535
22/61-12222	3	120	DAY DREAM RANCH 600	360353	1150657
20/61-19441	3	121	CLUB 95, 295	361133	1151117
20/61-33331	3	LG122	716 SHADOW LN, 226	360940	1150953

Appendix 2 (continued)

Location	S.P. Index	S.P. Designation	Description	Lat.	Long.
20/61-35322	3	LG123	1201 FREMONT 460	360957	1150756
21/61-044131	3	124	MICHELAS 1, 650	360857	1150926
21/61-044132	3	125	MICHELAS 2, 810	360857	1150926
20/61-18233	3	126	NLV AIR TERM 500	361239	1151214
20/61-29323	3	127	LORENZI PARK 600	361042	1151107
21/62-15332	3	128	AK LDS FARM 300	360743	1150241
20/61-30442	3	129	LV EXPWY ND VV 10	361034	1151127
21/62-08114	3	130	2633 SO NELLIS 90	360832	1150357
19/60-23144	3	131	HALVERSON 400	361706	1151331
20/60-19431	3	132	MELODY ND CYP 5	361127	1151126
20/61-304421	3	133	W OF WELL 15A 91	361033	1151129
20/61-304422	3	134	W OF WELL 15A 20	361031	1151129
20/62-21341	3	135	2100 BLEDSOE 215	361127	1150312
21/62-08431	3	136	2102 ALOHA 100	360753	1150408
21/61-12342	3	137	3208 S TOPAZ 375	360753	1150647
21/61-10144	3	138	2832 MARYLAND PKWY 6	360812	1150813
20/61-19422	3	139	1850 SYCAMORE 17	361134	1151136
19/60-23112	3	140	6261 WITTIG 208	361722	1151342
21/62-28412	3	LG141	RANCH HOUSE 140	360535	1150251

Appendix 3. Chemical Analyses of Las Vegas Valley Water Samples from February 1970 to April 1976

EXPLANATION OF WATER QUALITY CODES

CODING CONVENTIONS

Analytical data preceded by a minus sign (-), other than the categories immediately below, indicate the presence of this constituent in amounts "less than" the number shown. For example, -0.10 indicates a concentration less than one-tenth of a milligram per liter. The following codes are also used:

000000	analysis not regularly run for this constituent at this sampling point
-666660	constituent in solution not fully ionized. Milliequivalents were not calculable.
-77777	analysis or theory indicated none of this constituent to be present, e.g., it is chemically impossible for bicarbonate (HCO_3^-) to exist in aqueous solution at pH = 12
-88888	analysis revealed "trace" amounts of this constituent and was reported as "trace" by the lab
-99999	analysis usually run for this constituent at this sampling point, but not run for this sample

SAMPLE PRESERVATION

Samples taken for nitrogen compound analysis and preserved with mercuric chloride were coded M in the water analysis data system. All other analyses were done on unpreserved samples unless otherwise indicated. Code C indicates a seperate sample taken for phosphorus compound analyses and preserved with chloroform. All other analyses were done on unpreserved samples unless otherwise indicated. In general, only surface water samples expected to contain unstable nitrogen and phosphorus compounds were preserved.

ADDITIONAL INFORMATION

The Water Analysis Data System (WADS) of the Water Resources Center, Desert Research Institute, is well documented. Readers are encouraged to check the appropriate references for retrieving additional data concerning sampling and analyses that could not be put into this appendix because of space limitation. Information concerning sample preservation, trace element analyses, and elemental form (soluble, organic, suspended, colloidal) is available.

```
POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG  1 NEW HEND AP WELL      23S 61E 04 414 1
 3-25-70      13 -99.0   1144  7.78   150   180   180  -.10   7.8   135     9    60    31    .0    .8    678

LG  2 PITMAN ARTES WELL     22S 62E 01 321 1
 3-11-70      24  33.5   6108  7.86    92   403  1353   .20   -.5   615    37   222   450    .0   1.4   3126
10-17-70     292  22.2   5196  7.67   159   766  2407  -.10 116.0   424    20   414   433    .0   2.0   4660

LG  3 PARADISE V CC         22S 62E 08 324 1
 5-18-70      68  28.4   1070  8.00   153   101   332  -.10   2.0   100    12    90    43    .0    .5    755

LG  4 P HOL ADAIR  47       21S 63E 14 424 2
 6- 7-71     472  22.2   8745  7.50   332  1775  2383  -.10   -.1   875    88   724   436    .0   1.6   6446
 9-16-71     775  19.0   8622  6.58    23  1722  2519  -.10   -.0   885    83   564   424    .0   1.0   6210
12- 2-71     964  16.7   8387  6.51    84  1726  2542  -.10    .6   910    85   586   426    .8   1.4   6319
 5- 2-72    1420  20.0   7857  6.18    23  1887  2530  -.04   3.3   881    89   569   412    .0    .8   6384
 8- 2-72    1594  23.3   8698  5.37     2  1801  2568  -.08   1.0   871    84   530   414    .8    .7   6272

LG  5 P HOL ADAIR  100      21S 63E 14 424 2
 6- 7-71     473  22.2   8315  7.55   291  1476  2373  -.10  36.0  1023    72   516   341    .0   1.8   5982
 9-16-71     774  19.4   8064  7.38   243  1470  2397  -.10  24.0  1032    70   464   340    .0   1.7   5919
12- 2-71     945  18.9   7763  7.32   194  1496  2408  -.10  16.0  1032    74   443   340   2.0   1.7   5908
 5- 2-72    1421  21.7   7295  7.38   222  1427  2358  -.04  19.2  1001    78   470   322   2.0   1.7   5788
 8- 2-72    1593  25.6   8247  7.66   207  1456  2460  -.04  14.3  1024    74   450   334   2.0   1.7   5917

LG  6 OLD USGS GAGE 44      21S 63E 28 131 1
 6- 7-71     474  22.2   7931  7.39   190  1489  2103  -.10  89.0   782    83   619   302    .0   1.1   5561
 9-16-71     773  20.6   7436  7.37   188  1454  2061  -.10  78.0   787    80   594   303    .0   1.0   5451
12- 2-71     845  20.0   7117  7.39   213  1439  2063  -.10  67.0   777    84   583   300   1.0   1.1   5420
 5- 2-72    1422  21.1   6867  7.10   227  1400  2022  -.04  81.0   745    89   618   282   1.0   1.1   5350
 8- 2-72    1592  27.2   7525  7.29    68  1447  2084  -.04  10.0   774    85   494   281   1.0    .7   5210
11- 1-72    1738  20.0   6706  7.15   128  1444  1960  -.04  27.0   750    80   566   284   1.0    .8   5183
 2- 8-73    1927  18.9   6401  7.49   176  1482  2174  -.04  40.0   753    86   622   299    .9   1.0   5545
 5- 7-73    2043  21.1   7495  7.35   189  1509  2148  -.04  19.0   749    86   602   304   5.1 -99.0   5515
 8- 2-73    2188  22.2   7951  7.13   173  1502  2081 -9.99  22.0   732   104   596   306    .2 -10.0   5428

LG  7 OLD USGS GAGE 135     21S 63E 28 131 2
 6- 7-71     475  22.2   6966  7.35   241  1178  1950  -.10  73.0   689    82   585   270    .0   1.1   4947
 9-16-71     772  20.0   6553  7.56   228  1158  2033  -.10  54.0   685    80   549   269    .0   1.1   4942
12- 2-71     946  19.4   7429  7.28   201  1103  2011  -.10  36.0   678    83   520   269   2.5   1.0   4802
 5- 2-72    1424  22.8   6148  6.79   170  1204  2015   .04  31.0   661    87   541   263    .4   1.0   4887
 8- 2-72    1591  24.4   7023  7.67   168  1245  2063  -.04  24.0   657    83   535   274    .4   1.0   4965
11- 1-72    1739  20.0   6108  6.96   202  1243  2004  -.04  24.0   638    83   554   267    .4    .1   4913
 2- 9-73    1926  17.8   6543  7.80   114  1223  2084  -.04   4.9   655    85   537   273    .6   1.0   4919
 5- 7-73    2054  21.1   6659  7.08   112  1290  2049  -.04    .7   640    83   507   275    .5 -99.0   4900
 8- 2-73    2189  21.7   7194  7.17   182  1269  2019 -9.99  33.0   627   100   567   376    .3 -10.0   5081
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG  9 SNWP  LC 91              21S 63E 29 332 1
 9-16-71   765  21.9  7456  8.75   -77  1579  1871  -.10   6.0   831   164   488   260    .0    .3   5199
12- 2-71   882  22.2  7418  8.53   -77  1766  1630  -.10   5.2   767   153   531   276  15.0    .4   5144
 2- 2-72  1130 -21.7  7307  6.51     7  1742  1464  -.04   1.6   690   173   523   286  21.6   -.1   4825
 5- 6-72  2056  24.5  9144  9.06   -77  2031  1685  -.04   2.3   845   118   506   283  25.0 -99.0   5495
 7-31-72  1554  23.3 10414  8.87    45  2487  1897  -.04  17.3  1163   184   471   328  25.0    .3   6585
10-31-72  1743  22.2 12486  4.03   -77  3290  2016  -.10 121.0  1751   241   519   389  31.7 -99.0   8279
 2- 8-73  1938 -99.0  9505  7.77    95  2193  2292  -.10  26.9   960   175   680   391  28.0 -99.0   6784

LG 10 SNWP LC 42               21S 63E 29 332 2
 9-15-71   764  23.9  8075  8.35    45  1808  1945  -.10    .5   832    85   612   325    .0    .8   5630
12- 2-71   948  21.1  9044  8.20    10  2072  2320  -.10  51.0  1076    88   640   376  26.0   1.2   6655
 2- 2-72  1126  21.0  8136  7.15    51  1720  2015  -.04 143.0   875    79   537   304   4.3   1.2   5703
 3- 2-72  1303  22.2  7580  7.47    63  1633  1921  -.04 170.0   855    77   541   295   4.8   1.2   5529
 7-31-72  1555  31.7  8177  5.57     6  1715  2031  -.04  62.0   880    74   520   301   4.8   1.1   5590
 5- 7-73  2055  24.5  7535  7.71    39  1656  1925  -.04  77.0   841    70   473   294  14.0 -99.0   5369

LG 11 AK NO 36 LC 39           21S 63E 29 334 1
 9-16-71   766  21.6  6594  7.72   147  1282  1600  -.10 149.0   529    93   621   249    .0    .4   4596
12- 2-71   947  20.6  6363  7.61   152  1381  1456  -.10 179.0   520    93   588   246    .2    .4   4538
 2- 2-72  1111  18.1  6944  7.41   178  1648  1208  -.04 115.0   530    78   556   274   1.0    .7   4499
 5- 2-72  1426  22.2  6763  7.65   156  1713  1413  -.04 107.0   558    86   665   292   1.0    .7   4912
 7-31-72  1552  24.4  8387  7.67   149  2003  1438  -.04  78.0   639    89   700   322   1.0    .7   5344
10-31-72  1741  22.2  8254  7.87   121  2078  1516  -.10 110.0   615   112   764   338    .2 -99.0   5593
 1-29-73  1928 -99.0  7844  7.85   111  1847  1632  -.10 120.0   567   105   778   296    .2 -99.0   5400
 5- 7-73  2058  21.1  7269  7.49   177  1795  1251  -.04 152.0   748    75   515   244    .2 -99.0   4867

LG 12 AK NO 37 LC 38           21S 63E 29 334 2
 9-23-71   778  21.1  6098  7.31   208  1722   896  -.10 120.0   506    53   518   321    .0   1.1   4239
12- 2-71   965  19.4  6546  7.31   173  1630  1110  -.10 136.0   535    53   503   311    .0   1.3   4366
 2- 2-72  1110  17.0  7255  7.31   153  1796  1301  -.04  85.0   617    63   607   247    .0   1.2   4792
 5- 2-72  1425  21.7  7545  7.30   155  2019  1468  -.04  57.0   657    65   649   332    .0   1.2   5365
 7-31-72  1553  22.2  8969  7.63   150  2242  1252  -.04  95.0   793    67   667   305    .0   1.2   5496
 5- 7-73  2059  22.2  7259  7.45   177  1795  1224  -.04 162.0   802    57   490   229    .2 -99.0   4847

LG 13 BMI E UPPOND 250         22S 63E 05 322 1
 5- 8-71   494 -99.9  7160  7.40   121  1532  1533  -.10 152.0   485    51   700   299    .0    .8   4812
 9-16-71   767  26.2  7152  7.68   192  1483  1868  -.10  66.0   568    82   689   321    .0    .7   5172
12-22-71   984  23.3  7031  7.26    94  1517  1807  -.10 128.0   553    63   696   306   2.0    .7   5115
 2- 3-72  1142  26.0  6944  7.56    60  1464  1918  -.04  79.0   520    93   665   291   8.6    .6   5068
 3- 2-72  1298  26.1  6738  7.61   104  1478  1909  -.04  89.0   502    88   684   300   8.6    .6   5110
 5- 2-72  1431  27.8  6576  7.46   150  1447  1859  -.04 118.0   511    65   742   303   3.5    .8   5123
 8- 1-72  1559  27.8  7073  9.22    24  1472  1878  -.04   -.1   509    64   560   303  25.0    .4   4823
11- 2-72  1765  25.6  6201  7.25   108  1343  1962  -.04 155.0   484    69   671   313   5.7    .6   5057
 2- 8-73  1939  23.9  6694  7.50    20  1442  1945  -.04  14.0   524    67   589   294  24.0    .1   4808
 5- 7-73  2069  26.7  6708  8.38    25  1453  1795  -.04   5.4   515    73   562   300  27.0 -99.0   4742
 8- 2-73  2200  29.4  9082  7.37   156  1599  1939 -9.99  64.0   662    86   596   287   3.5 -10.0   5313
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMP  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4     F DS-SUM

LG 14 BMI E UP POND 45      22S 63E 05 321 2
 9-21-70   302  28.9   4015  7.66   283  1050   610  -.10  72.0    288     9   213   297    .0   1.5   2680
 8- 1-72  1560  25.6   5973  7.62   147  1568   832   .16 134.0    516    11   363   267    .0   1.0   3764
 2- 8-73  1969  22.2   5833  7.90   142  1462   741   .16 117.0    574    13   273   268   2.2 -99.0   3520
 5- 7-73  2070  21.7   6521  7.38    86  1795   651  -.04 134.0    620    12   304   304   6.5 -99.0   3869

LG 15 TL AND P ROS 25       21S 63E 30 323 1
 6- 9-71   483 -99.9   2904  7.50   327   239  1010  -.10    .1    252    26   255   103    .0    .9   2047
 9-15-71   762  20.0   2739  7.35   319   233   964  -.10   -.1    244    27   244   103    .0    .9   1973
12- 2-71   884  16.7   2605  7.47   255   246   927  -.10    .2    237    28   215   107   4.2    .8   1898
 2- 2-72  1125  13.1   2902  7.54   280   257  1067  -.04   1.5    230    26   259   110   4.4    .6   2093
 7-31-72  1559  24.4   2749  7.77   143   252   995   .10  13.4    236    27   175   111   4.4    .6   1885
11- 1-72  1749  19.4   2517  7.29   190   277   990  -.04   -.1    241    28   216   106   4.2    .7   1956
 2- 8-73  1933  16.7   2847  7.47   157   296  1040  -.04   -.1    289    30   201   114   3.8    .7   2052
 5- 7-73  2060  16.7   2832  7.29   167   282  1035  -.04    .3    271    28   197   112   6.1 -99.0   2014
 8- 2-73  2195  20.0   2946  7.41   161   279   949 -9.99    .2    260    26   183   102   4.1 -10.0   1882

LG 16 TL AND P ROS 47       21S 63E 30 323 2
10- 2-70   289  18.9   1985  7.26   139   304  1592   .14  17.0    335    44   377   119    .0    .5   2857
 6- 8-71   482 -99.0   3531  7.65   187   150  1837  -.10   -.1    247    25   330   215    .0   2.2   2898
 9-15-71   761  18.9   3398  7.47   164   146  1803  -.10   -.1    243    25   309   214    .0   2.2   2824
12- 2-71   883  16.7   3338  7.38   164   150  1723  -.10    .4    240    24   305   207   -.2   2.1   2737
 2- 2-72  1124  16.0   3389  7.44   179   150  1793  -.04   2.6    236    26   309   209    .1   2.0   2816
 7-31-72  1551  24.4   3511  7.86   154   144  1859  -.04    .3    240    25   317   217    .1   2.2   2880
11- 1-72  1750  16.7   3095  6.90   156   141  1838  -.04   -.1    232    24   312   208    .1   2.2   2805
 2- 8-73  1932  13.3   3372  7.42   165   141  1846  -.04   -.1    243    26   323   208    .2   2.2   2871
 5- 7-73  2061  20.0   3354  7.41   141   134  1781  -.04    .3    225    25   287   210    .2 -99.0   2732
 8- 2-73  2194  20.6   3663  7.14   126   147  1799 -9.99    .3    221    21   311   210    .2 -10.0   2771

LG 17 BMI L PONDS E 90      21S 63E 31 122 1
10- 3-70   284  27.5   6386  7.47    79  1349  2112  -.10   3.7    751    19   643   245    .0    .6   5162
10- 3-70   286  29.4   6543  7.62    77  1406  2169  -.10   3.4    765    95   695   247    .0    .6   5419
10- 6-70   287  25.6   7413  7.16   115  1539  2455  -.10-100.0    830   222   696   327    .0    .2   6126
 6- 8-71   479 -99.0  30776  7.49   131  4265 17796  -.10   -.1   3010  3700   520  2915    .0    .3  32271
 9-15-71   757  25.0  35504  4.78     9  4950 19490  -.10   1.6   3252  4480   525  3490    .0    .3  36193
12- 2-71   885  21.1  31850  6.76    65  4162 16300  -.10    .6   3220  3214   529  2843   2.4    .4  30303
 2- 2-72  1132  23.0  30574  7.18    83  4095 16639  -.04   2.5   3065  3074   514  2764   2.6    .3  30197
 3- 2-72    -0  23.3  29794  6.88    99  4180 16847  -.04   3.6   2980  3180   520  2842   4.1    .3  30606
 5- 4-72  1400  23.9  29022  6.77    61  3981 16655  -.04   2.8   3122  3280   527  2820   2.8    .3  30421
 8- 1-72  1618  26.7  32406  7.25    44  4247 17100  -.04    .6   3145  4130   524  2719   2.8    .3  31891
11- 1-72  1747  22.2  30641  5.66    14  4478 18431  -.04    .6   3216  4325   542  3058   2.8    .4  34053
 2- 8-73  1934  22.2  30996  5.61     2  4177 17291  -.04   -.1   3061  4112   556  2812   2.5    .5  32013
 5- 7-73  2062  22.2  30788  8.13    57  4244 16855  -.04    .7   2928  3770   552  2525   4.1 -99.0  30907
 8- 2-73  2198  25.6  37131  4.90    11  4844 19199 -9.99    .8   3252  4305   552  3140   2.6 -10.0  35381

LG 18 BMI L PONDS E19.5     21S 63E 31 122 2
 6- 8-71   478 -99.9   7581  7.45    82  1424  2212  -.10 136.0    790     7   712   266    .0    .8   5588
 9-15-71   758  26.7   7466  7.25    91  1638  2282  -.10 148.0    843    11   725   278    .0    .8   5962
12- 2-71   886  22.8   6991  7.47    89  1323  2324  -.10 148.0    802     8   672   260   1.5    .8   5583
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4     F  DS-SUM
 2- 2-72  1131  18.0   7068  7.42    79  1266  2265  -.04 145.0    699     5   673   240   -.1    .6   5341
 3- 2-72    -0  20.0   6727  7.43    94  1283  2279  -.04 150.0    703     4   671   249   -.1    .6   5306
 5- 4-72  1401  21.1   6669  7.20    88  1247  2240   .28 154.0    750     4   708   246   -.1    .8   5386
 8- 1-72  1619  34.4   7474  7.68    81  1233  2426  -.08 138.0    745     4   649   248    .1    .8   5484
11- 1-72  1768  24.4   7291  7.26    85  1242  2292  -.04 132.0    737     5   664   245    .1    .8   5360
 2- 8-73  1939  18.9   6906  7.20    82  1203  2399  -.04 126.0    708     7   639   244    .1    .6   5277
 5- 7-73  2063  21.1   6944  5.52    77  1256  2232  -.04 142.0    692     6   664   252    .1 -99.0   5202
 9- 2-73  2207  27.8   7436  7.18    81  1259  2203 -9.99 123.0    696    48   710   242    .1 -10.0   5321

LG 19 PMI L POND F 70         21S 63E 31 212 1
10- 8-70   296  23.6  10861  7.70   198  2817  2757  -.10  14.0   1942    48   650   326    .0    .9   8668
10- 9-70   297  22.3   7191  7.67   113  1043  1027  -.10   3.8    837    62   570   360    .0    .8   5559
 4-23-71   460  20.0   7605  7.39    77  1115  3160  -.10    .1    708   170   593   422    .0    .4   6206
 6- 8-71   480 -99.9   7992  7.50    69  1108  3208  -.10   -.1    764   177   573   420    .0    .4   6204
 9-15-71   759  21.1   7679  7.06    76  1110  3194  -.10    .3    743   164   558   415    .0    .4   6226
12- 2-71   950  18.9   7267  7.74    81  1122  3078  -.10    .3    767   159   557   418   1.6    .4   6143
 2- 2-72  1127  23.1   7586  7.49    71  1092  3217  -.04   1.7    741   202   555   409   1.6    .4   6255
 8- 1-72  1616  32.2   8926  7.88    57  1126  3377  -.08   1.0    744   190   549   421   1.6    .4   6438
10-11-72  1746  20.6   7734  7.88    76  1087  3348  -.10    .3    728   176   567   419    .3 -99.0   6362
 2- 8-73  1936  20.0   7786  7.95    75  1097  3335   .12    .3    773   160   554   413    .2 -99.0   6378
 5- 7-73  2065  23.3   7662  7.42    69  1094  3241  -.04    .3    753   201   549   420    .4 -99.0   6293

LG 20 AMI L PONDS E 20        21S 63E 31 212 2
 6- 8-71   481 -99.9  11586  7.65   244  2339  2670  -.10  16.7   1560    46   588   269    .0    .9   7610
 9-15-71   760  22.3  11160  7.65   254  2422  2670  -.10  11.4   1810    49   592   284    .0    .9   7965
12- 2-71   949  20.0  10292  7.44   256  2359  2612  -.10  11.0   1830    52   585   259   1.7    .9   7836
 2- 2-72  1125  20.0  11089  7.41   252  2457  2729  -.04   6.2   1787    52   610   264    .1    .9   8030
 3- 2-72  1299  20.6  10833  7.66   252  2489  2775  -.04   4.9   1837    57   580   281    .1    .9   8149
 5- 4-72  1402  21.1  10629  7.12   249  2489  2736  -.04   5.6   1643    55   636   276    .1    .9   7964
 8- 1-72  1617  25.6  11598  7.51   192  2427  2773  -.04    .7   1832    51   577   267    .1    .8   8023
10-11-72  1765 -99.0  11166  7.93   143  2463  2772  -.10  12.0   1792    84   515   278    .3 -99.0   7987
 2- 8-73  1937  18.9  11446  8.00   137  2597  2829  -.10   3.3   1890   108   590   280    .2 -99.0   8364
 5- 7-73  2064  20.0  12413  7.44   222  2899  2702  -.04   2.6   1935    60   666   299    .2 -99.0   8673

LG 21 L UPPER PONDS 40        21S 63E 31 331 1
 9-30-70   299  25.6   9906  7.65    72  1644  2817  -.10   2.1   1062   136   674   370    .0    .5   6741
 6- 8-71   476 -99.9  11715  8.45    45  2192  3391  -.10  50.0   1440   342   594   460    .0    .5   8492
 9-15-71   756  26.7   8580  8.85    56  2307  3366  -.10  79.0   1275   297   619   493    .0    .5   8464
12- 2-71   983  21.1  10530  8.20    38  2256  3260  -.10  83.0   1440   208   596   490   9.9    .5   8358
 2- 2-72  1133  23.0  10779  8.80    60  2194  3302  -.04  72.0   1358   293   606   461   7.3    .5   8313
 5- 2-72  1437  23.3  10046  8.76    53  2144  3165  -.04  56.0   1390   278   685   423   7.3    .3   8095
 8- 1-72    -0  24.4  11397  9.27    52  2182  3385  -.04  47.0   1360   237   587   474   9.5    .3   8308
11- 2-72  1766  22.8  11227  8.96   -77  2686  3103  -.04  39.0   1330   251   598   481  10.6    .3   8419
 2- 8-73  1939  22.2  10733  9.20   -77  2168  3386  -.04  56.0   1314   246   557   494  10.2    .4   8232
 5- 7-73  2071  23.3  10583  9.17   -77  2149  3228  -.04  44.0   1291   221   576   462  11.0 -99.0   7982
 8- 1-73  2199  24.4  11260  8.72   173  2178  3208 -9.99  31.0   1250   307   564   452  15.0 -10.0   8082

LG 22 L UPPER PONDS 22        22S 63E 31 331 2
 6- 8-71   477 -99.0   9459  7.15    83  1636  2778  -.10 170.0   1090    32   859   357    .0    .7   6784
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG 24 BMI W UPPOND 45      22S 63E 06 421 1
 6- 8-71   485 -99.0  7261  7.60   281  1746   872  -.10 138.0   530    25   501   326    .0   1.4   4278
 9-16-71   768  22.5  5579  7.75   264  1550   629  -.10  48.0   510    22   357   283    .0   1.5   3530
12- 2-71   985  20.6  5889  7.42   227  1578   946  -.10  76.0   548    22   382   338   1.2   1.6   4004
11- 2-72  1764  22.8  7675  7.81   155  2049   757  -.04 122.0   787    30   475   244   1.2    .8   4542

LG 25 TIMET DITCH 24       21S 63E 07 232 2
 9-16-71   770  25.0  7425  7.67   129  1444   599  -.10 186.0   364    44   328   305    .0    .5   3334
12- 2-71   951  21.7  3467  7.73    52   863   543  -.10  44.0   340    28   145   176   4.2    .6   2169
 2- 3-72  1136  20.0  4664  7.88   108  1151   697  -.04 110.0   386    24   240   237    .1   1.0   2809
 3- 2-72  1291  20.6  3874  7.66   127   877   681  -.04  72.0   345    20   194   193    .1   1.1   2446
 8- 1-72    -0  30.0  3381  7.97    92   636   685  -.04   9.2   343    18   119   139    .1   1.1   1996
11- 1-72  1763  25.6  2991  7.47   148   538   648  -.10  15.6   328    13   129   110    .1 -99.0   1851
 2- 8-73  1941  18.9  3142  8.00   132   587   645   .10  17.0   393    10   123    94    .2 -99.0   1934
 5- 7-73  2066  21.1  2528  8.07   105   270   826  -.04   1.9   349     8    87    78    .5 -99.0   1671

LG 26 TIMET DITCH 100      21S 63E 07 232 1
 6- 8-71   486 -99.9  7526  7.00    14  2387   213  -.10    .6   539    26   570   288    .0    .3   3893
 9-16-71   769  23.1  7324  7.47    40  2419   240  -.10   -.1   537    29   515   295    .0    .3   4055
12- 2-71   952  22.8  6891  7.15    54  2378   237  -.10   1.1   529    25   507   294   1.2    .3   4001
 2- 3-72  1137  19.0  7514  7.54    51  2438   250  -.04   2.0   530    26   529   294   1.2    .4   4096
 3- 2-72  1292  23.9  7159  7.44    52  2415   256  -.04   4.4   521    27   522   296   1.2    .3   4068
 5- 2-72  1436  24.4  7065  7.60    50  2407   260  -.04    .5   510    25   546   292   1.2    .3   4067
 8- 1-72  1557  24.4  7806  7.74    52  2431   270  -.04    .2   521    26   516   298   1.2    .3   4089
11- 1-72  1762  25.8  7414  7.98    58  2367     3  -.10    .2   506    27   526   290   1.2 -99.0   3749
 2- 8-73  1962  23.9  7334  8.00    23  2367     3  -.10    .2   542    36   462   264   1.2 -99.0   3687
 5- 7-73  2067  26.7  7328  7.36    50  2347   252  -.04   -.1   505    24   494   265   1.2 -99.0   3913

LG 27 BMI L PONDS W 62     21S 62E 36 211 1
10-16-70   293  24.4  8156 10.78   -77  2062  1333   .28   6.7  2017    35    83 -1000    .0   1.4   5538
 6- 9-71   496 -99.9  8888  7.90   150  2159  1238  -.10   6.1  1814    20   221    42    .0   2.0   5576
 9-14-71   753 -99.9  9282  7.94   142  2384  1330  -.10   2.3  1665    24   321    73    .0   2.0   5872
12- 3-71   959  18.9  8613  7.52   156  2302  1379  -.10   8.0  1683    26   384    94   1.7   1.9   5956
 2- 2-72  1134  20.0  8086  7.66   167  1911  1329  -.04  34.0  1435    24   305    81   1.7   2.1   5205
 3- 2-72  1296  21.7  7685  7.70   165  1915  1334  -.04    .2  1465    29   240    80   1.7   2.0   5189
 5- 4-72  1403  21.1  7086  7.43   179  1713  1292  -.04   2.4  1353    23   289    73   1.7   2.2   4838
 8- 1-72  1613  22.8  7695  7.81   183  1623  1442  -.04    .9  1325    23   277    81   1.7   2.3   4867
11- 1-72  1767  22.2  7014  7.54   135  1443  1516  -.10    .2  1275    29   284    80    .0 -99.0   4694
 2- 8-73  1945  21.7  6923  8.12   161  1424  1495  -.10    .3  1271    30   253    83    .4 -99.0   4636
 5- 8-73  2075  26.7  6285  7.62   186  1223  1365  -.04   -.1  1107    19   242    67    .4 -99.0   4116

LG 28 BMI L PONDS W19.5    21S 63E 36 211 2
 6- 9-71   495 -99.9 10740 11.15   -77  2501   931   .62  34.0  2355     8    11     1    .0    .7   5841
 9-14-71   754  21.7 10448 11.22   -77  2413  1314   .56   8.4  2525     8    14    -0    .0    .8   6284
12- 3-71   958  20.0  9475 11.09   -77  2497  1277   .40   2.3  2410     9    24    -0   2.2    .9   6133
 2- 2-72  1135  17.8  9224 11.25   -77  2106  1298   .58  10.4  2145    10    -0    -0    .2   1.0   5572
 3- 2-72  1295  18.3  7791 11.07   -77  1944  1275   .72  10.3  2083    13    20     1    .2   1.0   5349
 5- 4-72  1404  18.9  7816 11.35   -77  1849  1253  1.72   4.4  2023     7     4     0    .2   1.0   5143
 8- 1-72  1614  23.3  8628 11.10   -77  1664  1416   .66   2.3  1915     9    22     2    .2   1.0   5031
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
11- 1-72  1768  23.3  8164 10.98   -77  1520  1486   .96   1.5  1905     2    25    -8    .2 -99.0   4941

LG 29 DUCK CK AT LVW100     21S 62E 26 421 1
 4-22-71   651 -99.9  5444  7.86   147   674  2658  -.10    .8   411    68   548   298    .0   1.2   4681
 6-10-71   699 -99.9  5728  7.65   137   587  2678  -.10   -.1   480    70   562   306    .0   1.1   4751
 9-14-71   752  20.6  5569  7.66   141   591  2621  -.10   -.1   454    69   570   303    .0   1.2   4679
12- 3-71   961  17.0  6406  7.50   144   580  2598  -.10    .9   404    63   559   306   2.0   1.1   4673
 2- 2-72  1099  10.0  5493  7.50   141   575  2621  -.04   2.1   442    72   543   301   2.0   1.2   4629
 7-31-72  1549  21.1  5709  7.50   142   574  2401  -.04    .6   446    70   547   303   2.0   1.2   4814
11- 2-72  1770  18.9  5513  8.37   135   568  2740   .20    .5   450    75   550   303    .1 -99.0   4753
 5- 8-73  2077  21.7  5489  7.26   122   557  2639  -.04    .7   420    68   519   298    .2 -99.0   4561

LG 30 DUCK CK AT LVW 30     21S 62E 26 421 2
 6- 9-71   497 -99.0  8737  7.70   270  1168  3228  -.10   1.6   805   111   632   456    .0   1.0   6616
 9-14-71   755  19.4  8369  7.70   260  1346  3249  -.10    .7   897   100   616   433    .0   1.7   6771
12- 3-71   960  17.8  8000  7.18   229  1337  3268  -.10   1.0   958   105   597   482   2.6   1.5   6865
 2- 2-72  1098  17.0  8395  7.28   259  1326  3338  -.04   2.3   925   126   588   469   2.6   1.6   6986
 7-31-72  1548  23.3  8608  7.55   168  1330  3285  -.04    .3   922   109   558   438   2.6   1.6   6719
11- 3-72  1769  18.9  8379  7.26   263  1283  3082  -.04   3.6   903   111   581   424   2.6   1.7   6521
 2- 8-73  1946  17.8  8057  7.30   190  1243  3186  -.04   4.2   921   109   512   414    .1   1.7   6402
 5- 8-73  2076  25.6  7908  7.10   198  1272  2958  -.04    .3   862   104   526   397    .4 -99.0   6217
 8- 1-73  2203  22.2  8486  7.30   213  1337  2903 -9.99    .2   875   113   545   397    .4 -10.0   6275

LG 31 GIBSON RD 62          22S 62E 11 322 1
 6- 8-71   487 -99.0  4157  7.70    86   975   372  -.10  18.0   240    23   291   159    .0    .6   2121
 9-14-71   751  24.4  4356  7.56    76  1008   377  -.10  22.0   286    23   297   169    .0    .6   2220
12- 3-71   986  22.2  3984  7.64    94  1014   367  -.10  36.0   282    23   294   169   1.5    .6   2233
 2- 3-72  1139  24.0  4249  7.44    94  1035   379  -.04  28.0   271    21   300   171   1.5    .7   2253
 5- 4-72  1407  24.4  4158  7.50    93  1058   389  -.04  37.0   284    22   325   178   1.5    .6   2341
 8- 2-72  1581  27.8  4605  7.72    87  1078   448  -.04  20.0   296    23   321   185   1.5    .7   2424
11- 2-72  1760  23.3  4775  7.56   100  1134   413  -.04  32.0   306    25   344   189   1.5    .6   2494
 2- 8-73  1944  23.3  4826  7.53    97  1144   440  -.04  46.0   325    25   322   194   1.5    .8   2546
 5- 8-73  2047  24.4  4820  7.54    99  1193   412  -.04  50.0   296    22   345   201    .1 -99.0   2568
 8- 1-73  2202  26.7  5176  7.55   102  1182   443 -9.99  32.0   313    21   357   203    .1 -10.0   2621

LG 32 STAUFF DITCH 150      22S 62E 11 413 1
 8-26-70   224  28.9  7681  7.48   153  1606  2553  -.10  13.0  1507    41   567    94    .0   3.0   6460
 8-27-70   226  35.0  4569  7.65    97   935  1632  -.10   -.1   746    33   300   108    .0   2.3   3604
 8-28-70   229  32.2  7361  7.50   165  1371  2796   .26    .0  1332    41   616   135    .0   3.4   6377
 8-28-70   230  32.2 17097  7.60   137  3810  2901  -.10    .5  2217    59   788   376    .0   3.9  10223
 8-29-70   228  29.9 12619  7.57   264  3820  2493   .48   -.1  2221    50   825   357    .0   3.0   9900
 8-29-70   231  29.4 12927  7.31   155  4087  2352  -.10    .7  2205    48   842   465    .0   2.8  10079
 8-29-70   232  27.9 12917  7.19   156  4182  2182  -.10   -.1  2207    37   717   460    .0   2.3   9863
 8-31-70   233  26.7 12911  7.30   142  4202  2052  -.10   -.1  2182    33   713   475    .0   1.9   9729
 8-31-70   239  29.2  5579  7.77   165  1556   909  -.10   1.0   838    21   296   180    .0   1.1   3896
 9- 1-70   235  27.8   913  7.93   103   172   172  -.10   5.4   152     7    33    14    .0    .6    607
 6-10-71   498 -99.0 14729  7.42   330  3930  1976   .12   -.1  2164    29   700   426    .0   2.3   9398
 9-16-71   771  25.9 11598  7.48   285  3115  1610  -.10   -.1  1687    26   548   336    .0   2.1   7384
12- 2-71   953  25.0  6671  7.45   214  1807  1029  -.10    .4  1060    19   315   196   2.0   1.5   4535
 2- 3-72  1141  25.6  6115  7.37   201  1525   932  -.04   1.9   858    14   255   156    .1   2.0   3843
 5- 2-72  1297  25.6  5453  7.51   185  1371   867  -.09   2.9   835    18   232   151    .1   1.4   3569
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F DS-SUM
 8- 2-72  1598  30.8   2328  9.09   100   470   314  -.04   -.1   308     8    71    49    .1    .0   1270
11- 2-72  1761  25.0   9352  7.04   238  2327  1380  -.04   -.1  1310    21   423   264    .1   2.0   5844
 2- 8-73  1943  24.4   2516  7.51   120   529   384  -.04   -.1   344    10    91    57    .1    .9   1475
 5- 7-73  2969  28.3   2194  7.39   112   437   318  -.04    .3   276     8    77    45    .1 -99.0   1218
 8- 1-73  2201  28.3   7174  7.34   184  1674  1041 -9.99   -.1   905    15   283   184    .1 -10.0   4193


LG 34 AK UP CROSS 35        21S 62E 15 441 1
 6-10-71   503 -99.9   6287  7.70   268   427  3087  -.10  53.9   674    41   446   354    .0   1.6   5215
 9-14-71   744  18.0   5804  7.64   268   388  3050   .14  51.0   638    37   432   341    .0   1.6   5070
12- 3-71   991  17.9   5383  7.46   265   378  2830  -.10  41.0   625    37   399   340   2.0   1.6   4784
 2- 3-72  1140  17.0   5514  7.45   265   367  2874  -.04  32.0   575    30   388   353   2.0   1.8   4753
 3- 2-72  1304  16.1   5896  7.80   272   436  3094  -.04  42.0   649    39   417   359   2.0   1.6   5174
 5- 4-72  1419  20.0   6044  7.40   294   459  3329  -.04  35.0   659    39   471   420   2.0   1.6   5590
 7-31-72  1544  24.4   6341  7.79   301   456  3236  -.06  28.0   671    42   443   389   2.0   1.8   5417
11- 3-72  1773  18.9   5665  7.53   270   372  2835  -.04  22.0   555    42   464   325   2.0   1.9   4752
 2- 9-73  1957  18.3   5785  7.54   271   408  3075  -.04  36.0   605    38   419   391   2.0   1.8   5101
 5- 8-73  2072  20.0   6482  7.58   310   481  3378  -.04  35.0   667    40   445   429    .2 -99.0   5627
 8- 2-73  2219  20.8   6831  7.52   333   481  3327 -9.99  58.0   705    43   424   405    .1 -10.0   5599


LG 35 OPI UP CROSS 105      21S 62E 15 441 2
10-12-70   283  18.1   1761  7.43   125   267  2741  -.10  18.0   429    28   475   289    .0   1.5   4310
 6-10-71   502 -99.0   1663  7.65   202    46   704  -.10    .1    87    11   146    96    .0   1.7   1191
 9-14-71   743  21.1   1525  7.84   170    45   657   .10   -.1    81    12   126    91    .0   1.7   1096
12- 3-71   998  18.9   1475  6.80   193    44   599  -.10   -.1    79    10   117    88   1.8   1.7   1035
 2- 3-72  1138  20.0   1575  7.53   203    45   677  -.04   -.1    75    11   137    93   1.8   1.8   1141
 3- 2-72  1305  19.9   1569  7.77   214    49   690  -.09   1.9    77    11   142    95   1.0   1.0   1182
 7-31-72  1545  22.2   1605  7.98   138    50   694  -.04   -.1    79    11   119    95   1.8   1.6   1116
11- 3-72  1772  20.6   1544  7.57   132    46   680  -.04   -.1    81    10   119    94   1.8   1.6   1090
 2- 9-73  1956  20.0   1514  7.75   152    46   671  -.04   -.1    78    11   126    91    .1   1.7   1100
 5- 8-73  2073  22.2   1574  7.65   123    51   696  -.04   -.1    77    13   120    98    .2 -99.0   1115
 8- 2-73  2228  21.1   1867  7.57   107    62   815 -9.99    .3    93    10   139   107    .2 -10.0   1280


LG 36 COUNTY STP 50         21S 62E 22 241 1
 6- 9-71   693 -99.0   6020  7.50    65   856  2754  -.10  50.0   751    26   488   318    .0   1.0   5204
 9-14-71   765  28.6   5554  7.29    84   708  2270  -.10   1.3   527    24   471   270    .0   1.0   4322
 9-14-71   765  28.6   8080  8.11    60   981  3455  -.10    .9  1117    33   455   326    .0    .9   6308
12- 3-71   965  18.3   4845  7.65    56   680  1999  -.10    .4   447    18   420   256  10.0   1.0   3866
 2- 3-72  1170  18.9   3959  7.52    91   614  1330  -.04   2.7   265    15   317   206   1.0    .9   2805
 3- 2-72  1306  19.3   3800  7.45   125   683  1327   .36   3.1   264    18   316   203   5.2   1.1   2822
 5- 3-72  1406  22.2   3647  7.47    36   597  1276  -.04   5.6   271    15   288   206   6.4    .9   2681
 7-31-72  1544  27.3   4013  7.82    49   592  1292  -.04   -.1   268    17   247   205   6.4    .9   2673
11- 3-72  1771  20.0   3896  7.71    30   612  1213  -.04   -.1   259    16   265   207   6.4    .9   2594
 2- 9-73  1955  19.4   4039  7.56    39   623  1453  -.04   -.1   313    17   241   223   6.4   1.0   2936
 5- 8-73  2074  22.2   4310  7.52    46   656  1508  -.04   -.1   326    17   292   234  11.0 -99.0   3059
 8- 2-73  2221  21.1   4833  7.50    48   683  1613 -9.99   -.1   366    18   318   244  10.0 -10.0   3274


LG 37 COUNTY STP 31         21S 62E 22 241 1
 6- 9-71   694 -99.0   9651  7.55    98   908  3682  -.10 130.0  1165    30   552   353    .0   1.0   6861
 9-14-71   766  23.3    797  7.95   157     9   270  -.04    .6    12     4    72    39    .0    .4    434
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F DS-SUM

LG 38 WHITNEY MESA 112      22S 62E 04 232 1
 6-11-71   504 -99.0   1213  7.63   136   120   310  -.10   1.3   103    12    75    43    .8    .5    732
 9-14-71   758  21.1   1241  7.92   134   135   303  -.10    .6   108    11    73    45    .8    .6    742
12- 3-71   954  20.6   1161  7.55   137   124   302  -.10   2.3   100    11    76    45   1.7    .5    728
 2- 2-72  1044  20.0   1181  7.75   133   129   306  -.04   1.2   100    11    73    43   1.7    .5    730
 8- 2-72  1589  20.3   1264  7.88   113   134   314  -.04   1.1   101    10    76    44   1.7    .6    735
11- 1-72  1759  21.7   1211  8.33   132   131   316   .12   1.2   103     6    82    43   1.7 -99.0    740
 2- 9-73  1950  15.6   1191  8.25   134   131   317   .18    .3   103     6    83    43   1.7 -99.0    751
 5- 6-73  2046  22.2   1208  7.67   133   128   303  -.04   3.2    93     9    72    43   1.7 -99.0    718

LG 39 WHITNEY MESA 40       22S 62E 04 232 2
 6-11-71   507 -99.0   6075  7.30   206   709  1083  -.10   -.1   286    39   378   179    .8   1.2   2776
 9-14-71   749  20.6   6029  7.57   137   713  1069  -.10   -.1   271    39   364   181    .8   1.3   2706
12- 3-71   987  19.4   3768  7.15   166   726  1005  -.10    .5   265    38   332   182   2.0   1.3   2633
 2- 1-72  1045  20.0   3999  7.33   175   736  1023  -.04   1.3   269    41   334   186   2.0   1.1   2684
 8- 2-72  1538  25.0   4113  7.58    88   746  1022  -.06   1.3   266    37   298   181   2.0   1.1   2598
11- 1-72  1758  20.0   4052  9.13   102   763  1098  -.10   -.1   266    41   338   196   2.0 -99.0   2746
 2- 9-73  1949  19.4   4142  8.15   103   778  1108  -.10    .2   295    45   300   202   2.0 -99.0   2763
 5- 6-73  2045  20.6   4033  7.45   103   766  1036  -.04   -.1   271    40   295   197   2.0 -99.0   2658

LG 40 WHITNEY MESA 110      22S 62E 04 232 3
 6-11-71   506 -99.0   1322  7.70   127   138   366  -.10    .1    98    12    94    52    .8    .4    795
 9-14-71   762  21.7   1307  7.81   117   144   337  -.10   -.1    94    13    83    58    .8    .4    787
12- 3-71   955  20.6   1326  7.67   126   149   332  -.10    .6    93    13    93    54   1.3    .5    798
 2- 1-72  1097  21.0   1254  7.62   117   142   335  -.04   -.1    86    11    84    54   1.3    .4    771
 8- 2-72  1608  27.2   1374  7.94   128   148   336  -.06   -.1    85    12    86    55   1.3    .4    786
11- 1-72  1757 -99.0   1251  8.42   118   146   340   .16    .1    83    12    94    52   1.3 -99.0    794
 2- 9-73  1968  18.3   1215  8.37   117   142   342   .16    .2    85    30    94    53   1.3 -99.0    805
 5- 6-73  2044  22.2   1255  7.62   119   144   328  -.04   -.1    84    12    83    52    .2 -99.0    761

LG 41 UPPER LVW 67          20S 62E 32 121 1
 6- 9-71   498 -99.0    980  7.95   194    37   322  -.10   -.1    40    10    55    72    .8   1.0    632
 9-27-71   788 -99.0    786  7.96   235    29   165  -.10    .4    33     8    40    55    .8   1.3    449
12- 3-71   989  18.9    708  8.27   267    42   149  -.10   -.1    35     9    40    55   1.5   1.2    464
 2- 1-72  1149  18.9    697  8.16   269    27   176  -.04   -.1    29     8    34    53   1.5   1.1    469
 7-31-72  1541  21.1    663  7.97   250    23    94  -.08   2.0    29     8    29    53   1.5   1.2    368
11- 1-72  1754  20.0    683  8.89   262    19   110  -.04    .8    29     7    33    50   1.5   1.1    384
 2-12-73  1961  20.0    688  7.98   298    18   107  -.04   -.1    27     7    26    48    .1   1.2    380
 5- 6-73  2049  21.1    536  8.51   188    16    79  -.04    .4    20     7    18    44    .1 -99.0    274

LG 42 UP LVW 170            20S 62E 32 121 2
 6- 9-71   689 -99.0    955  7.85   253    31   258  -.10   2.9    29     8    49    79    .8   1.0    581
 9-13-71   737  21.1    915  7.97   251    32   276  -.10   1.8    33    10    46    73    .8   1.1    597
12- 3-71   988  18.9    860  7.64   256    35   222  -.10   1.2    27     9    46    75   1.7   1.1    542
 2- 1-72  1096  20.0    860  7.48   252    29   234  -.04   2.7    26     7    39    77   1.7   1.0    539
 7-31-72  1560  21.1    887  8.29   236    39   208  -.04   -.1    20     7    38    73   1.7   1.2    513
11- 1-72  1753  20.0    971  7.59   249    30   282  -.04   3.0    21     7    44    81   1.7   1.0    594
 2-12-73  1969  20.0    876  7.69   261    37   264  -.04   1.7    28     8    41    78   1.7   1.2    583
 5- 6-73  2068  25.6    911  9.11   239    41   266  -.04   -.1    32     8    41    74    .6 -99.0    596
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMB   TEMP   COND    PH   HCO3    CL    SO4    PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 8- 2-73   2216   27.2   1090  7.42   229     68    257  -9.99   1.1    67     8    46    81    .6 -10.0     615

LG 63 NO NAME SP 56          21S 62E 29 434 1
 6-11-71    589  -99.0   3749  7.22   246    364   1469   -.10    .2   245    39   420   169    .8   1.6    2828
 9-16-71    768   20.6   3703  7.52   172    373   1435   -.10   -.1   233    41   383   161    .8   1.7    2712
12- 3-71    956   16.4   3219  6.89   165    355   1265   -.10    .6   238    38   383   158   1.5   1.6    2434
 2- 1-72   1151   20.0   3316  7.19   226    362   1267   -.06   1.6   235    37   315   159   1.5   1.6    2486
 8- 1-72   2216   27.2   3320  6.93   198    366   1172  -9.99   -.1   235    36   236   162   1.5 -10.0    2302
 8- 2-72   1610   22.2   3511  7.73   198    365   1269   -.06   1.9   231    38   287   165   1.5   1.6    2447
11- 2-72   1755   19.4   3407  6.95   200    372   1229   -.06    .2   222    36   298   166   1.5   1.7    2417
 2- 9-73   1952   20.0   3271  6.93   149    365   1256   -.06   -.1   229    38   275   161    .2   1.7    2397
 5- 6-73   2063   21.1   3236  6.73    98    373   1209   -.06   -.1   217    36   296   160    .8 -99.0    2295

LG 64 NO NAME SP 129         21S 62E 29 434 2
 6-11-71    986  -99.0   3643  7.25   206    391   1352   -.10    .6   272    35   347   175    .8   1.2    2665
 9-16-71    767   21.7   3596  7.96   165    392   1295   -.10   -.1   239    35   319   175    .8   1.1    2537
12- 3-71    957   19.6   3336  7.70   170    382   1279   -.10    .6   228    26   306   174   1.5   1.2    2479
 2- 1-72   1152   20.0   3380  7.18   219    378   1307   -.06   1.7   231    36   318   176   1.5   1.2    2558
 8- 2-72   1609   21.7   3671  7.72   146    366   1311   -.08    .6   227    33   296   182   1.5   1.1    2500
11- 2-72   1756   19.6   3669  7.16   138    388   1283   -.06   -.1   222    33   268   180   1.5   1.0    2444
 2- 9-73   1951   19.6   3302  7.30   135    386   1325   -.06   -.1   229    36   271   179   1.5   1.1    2491
 8- 2-73   2217   26.1   3501  7.22   187    376   1290  -9.99    .2   239    32   266   182   1.5 -10.0    2415

LG 65 CAMPBELL RES 129       21S 62E 19 111 1
 6-15-71    500  -99.0   1076  7.28    66     12    506   -.10   -.1    28     5   139    58    .8    .4     763
 9-16-71    768   22.2    833  6.93    68     13    354   -.10   -.1    28     6    81    46    .8    .3     556
12- 3-71    982   20.6    797  7.88   101     31    292   -.10   -.1    25     5    75    45   1.0    .6     526
 2- 1-72   1153   22.0    653  7.57   136     16    219   -.06   -.1    17     3    66    37   1.0    .6     425
 8- 2-72   1611   23.3    587  8.11   122     15    157   -.06    .2    16     4    59    34   1.0    .6     329
11- 3-72   1776   22.2    567  7.72   126      9    153   -.06   -.1    15     3    37    35   1.0    .6     315
 2- 9-73   1953   19.6    576  7.72   133     11    150   -.06   -.1    17     4    36    35    .1    .6     317
 5- 6-73   2052   25.0    566  7.91   128     10    156   -.06   -.1    19     3    36    36    .1 -99.0     323
 8- 3-73   2223   22.2    596  7.88   140     10    161  -9.99   -.1    17     2    68    43    .1 -10.0     348

LG 66 CAMPBELL RES 60        21S 62E 19 111 2
 6-10-71    501  -99.0    876  7.60   106     22    275   -.10    .6    18     3    96    44    .8    .3     551
 9-16-71    761   22.2    839  7.66   166     21    266   -.10    .5    22     3    73    46    .8    .3     516
12- 3-71    993   20.0    887  7.46   180     28    296   -.10   -.1    23     3    98    49   1.2    .3     578
 2- 1-72   1156   21.0    886  7.56   171     26    316   -.06    .7    26     2    98    49   1.2    .3     592
 8- 2-72   1612   22.8   1076  7.85   165     30    373   -.06    .5    36     3   109    61   1.2    .5     701
11- 3-72   1775   21.7    959  7.36   129     36    344   -.06   -.1    33     3    78    58   1.2    .2     616
 2- 9-73   1956   21.1   1030  7.55   162     42    383   -.06   -.1    37     6    97    59    .1    .6     701
 5- 6-73   2053   22.0   1196  7.76   177     69    619   -.06   -.1    40     3   117    66    .1 -99.0     799
 8- 3-73   2222   23.3   1332  7.28   193     68    659  -9.99    .6    46     2   131    69    .1 -10.0     868

LG 67 CHARLES BLVD 189       20S 61E 36 444 1
 6- 8-71    692  -99.0    669  8.08   198      9     88   -.10    .4    12     4    57    36    .8    .4     278
 9-13-71    738   21.7    676  8.08   166     10     77   -.10    .4    10     5    75    32    .8    .6     235
12- 3-71    963   20.6    696  7.71   181     11    171   -.10   -.1    10     5    67    36   1.6    .6     316
 2- 1-72   1150   21.0    646  7.92   198      7     87   -.06    .6     8     3    56    33   1.6    .5     268
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4     F  DS-SUM
 7-31-72   1963  23.3    757  7.98   157     8   220  -.06    .5     12     6    72    39   1.6    .6     435
11- 1-72   1751  20.6    677  7.96   179     6   199  -.06    .6      8     6    66    36   1.6    .6     389
 2-12-73   1958  20.6    532  7.90   179     1   128  -.06   -.1     16     6    62    36   1.6    .5     315
 5- 6-73   2058  26.6    498  7.86   188     6   101  -.06    .7      8     6    36    33    .2 -99.0     275
 8- 2-73   2217  23.9    658  4.12   169    12    83 -9.99    .1     14     2    25    33    .2 -10.0     292

LG 48 CHARLSTON BLVD 48     20S 61E 36 444 2
 6- 9-71    491 -99.0   2765  7.50   225   117  1309  -.10   -.1    148    26   202   200    .8    .4    2121
 9-13-71    739  22.2   2773  7.55   175   129  1250  -.10   -.1    168    28   196   200    .8    .3    2065
12- 3-71    962  18.9   2272  7.07   216   126  1110  -.10   -.1    139    23   192   173   1.2    .3    1856
 2- 1-72   1149  21.0   2647  7.29   196   125  1181  -.06    .3    136    60   171   192   1.7    .3    1969
 7-31-72   1562  23.3   2578  7.90   120   126  1195  -.06    .6    135    26   150   190   1.2    .2    1871
11- 1-72   1757  20.6   2038  6.86    92   176  1168  -.06   -.1    125    26   136   186   1.2    .2    1818
 2-12-73   1959  20.6   2302  7.40   157   113  1090  -.06   -.1    127    23   155   171    .1    .3    1757
 5- 6-73   2051  22.2   2395  7.55   127   129  1087  -.06   -.1    137    28   136   188    .1 -99.0    1739
 8- 2-73   2218  23.5   2642  7.37   134   126  1140 -9.99    .1    129    22   143   186    .1 -10.0    1808

LG 49 AK NO POLE 35          21S 63E 29 332 1
 6-11-71    509 -99.0   7570  7.62   206  1602  1688  -.10 132.0    527   142   795   327    .8    .5    5217
 9-15-71    763  22.0   8385  7.39   200  1903  1561  -.10 118.0    542   168   763   357    .8    .7    5455
 2- 2-72   1128  20.0   7773  7.27   180  1864  1597  -.09  72.0    536   151   692   336    .1    .6    5336
 5- 2-72   1427  21.7   8826  7.40   163  2049  1665  -.06  62.0    652   196   786   369    .1    .6    5848
 7-31-72   1556  20.9   9280  7.71   157  2080  1771  -.06  95.0    719   168   762   367    .1    .7    5988
10-31-72   1762  21.1   9615  7.91   126  2309  1876   .12 103.0    860   168   675   331    .1 -99.0    6373
 2- 8-73   1931  20.0   9696  7.80   161  1926  1813   .16 109.0    940   140   677   255    .1 -99.0    5937
 5- 7-73   2057  23.3   8620  7.21   160  1996  1687  -.06 139.0   1042   153   622   235    .5 -99.0    5957

LG 50 LVDM WELL WATR 20     21S 62E 35 441 1
 5-17-71    471 -99.0   5196  7.05   196  1067  1071  -.10   2.4    600    30   300   146    .8   1.2    3322
 6-11-71    520  21.0   6730  7.62   193  1486  1269  -.10   1.7    932    35   397   178    .8   1.1    4395

LG 51 AF LC COMP 30         21S 63E 29 323 1
 3-10-71    371 -99.9   5109  7.24   305   415  2695  -.10    .8    403    60   606   272    .8   1.3    4373
 3-10-71    372 -99.9   5160  7.28   328   490  2282  -.10   2.2    438    37   635   251    .8   1.3    4294

LG 52 AK LC COMP 39         21S 63E 29 323 2
 3-10-71    378 -99.9   6701  7.36   206  1267  1677  -.10 152.0    540   136   629   261    .8    .6    4778

LG 53 AK LC COMP 30         21S 63E 29 323 3
 3-10-71    369 -99.9   6973  7.40   195  1274  1850  -.10 136.0    570   130   662   267    .8    .6    4925
 6-22-71    660  18.9   6665  7.95   210  1096  1897  -.10  81.5    521   116   557   340    .8    .6    4712

LG 54 AK LC COMP 30         21S 63E 29 333 1
 3-10-71    377 -99.9   6793  7.13   231  1220  1525  -.10 160.0    673   182   573   256    .8    .9    4389
 6-22-71    659  20.0   6496  7.95   192  1677  1676  -.10 136.0    617    96   657   299    .8   1.0    4746
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POINT IDENTIFIER AND LOCATION
NO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG 55-AK NO 16LC 33        21S 63E 29 332 4
 9-23-71   776  21.9  8496  7.27   182  2019  1529  -.10 116.0   622   147   710   339    .0    .5   5572
 2- 1-72  1167  22.0  7825  7.48   165  1849  1684  -.04  83.0   635   161   688   338   -.1    .6   5520
 5- 2-72  1428  22.2  8045  7.29   152  2019  1750  -.04  85.0   753   165   740   322   -.1    .6   5909

LG 56 NEV PS WASH WATER    21S 62E 11 232 1
 3-31-70    25 -99.9  2381  7.67   207   107  1202  -.10   7.5   172    13   208   161    .0   1.5   1975
 5- 4-70    35  23.0  2216  7.70   203    83  1252  -.10  18.4   172    14   205   168    .0   1.5   2014
 6- 4-70    79  28.6  2261  7.80   210    76  1175  -.10   7.5   187    15   193   166    .0   1.5   1925
 7- 7-70   107  23.3  2284  7.90   207    77  1151  -.10   9.2   172    14   196   162    .0   1.5   1885
 8- 6-70   143  24.4  2222  8.09   208    83  1156  -.10  16.8   172    16   195   160    .0   1.5   1902
 9-11-70   206  25.6  2332  8.00   212    83  1188   .13  17.4   167    16   200   150    .0   1.5   1928
 9-11-70   207  25.6  2488  8.12   212    77  1238  -.10   8.3   185    16   204   158    .0   1.7   1992
 3- 2-72  1294  21.1  2537  7.95   218    90  1288  -.04   8.4   184    16   209   160    .0   1.6   2056

LG 57 NO 2 NELLIS AFB      20S 61E 03 412 1
 6-15-71   547  23.6   411  8.00   225     8    33  -.10   1.2     9     1    47    23    .0    .2    234

LG 58 NLV LOSEE WELL       20S 61E 15 433 1
 6-15-71   546  23.3   605  7.99   232    25   107  -.10   2.5    13     2    75    35    .0    .1    373

LG 60 CCSTP DEWATER SH     21S 62E 22 224 2
 1- 0--0  1414 -99.0  6982  7.54   202   748  3423   .12 101.0  1015    59   524   310    .0   1.4   6281
 2- 1-72  1207  19.0  7255  7.51   207   696  3510  -.04  84.0   966    79   534   333    .0   1.6   6306
 3- 2-72  1307 -99.0  7306  7.73   204   748  3584   .10  98.0  1049    69   502   319    .2   1.4   6471
 5- 1-72  1458  21.1  7284  7.58   198   716  3558   .28  92.0  1067    62   496   332    .2   1.3   6422
 7-31-72  1567  22.2  7976  7.70   209   808  3548   .20  84.0  1047    43   548   329    .2   1.4   6512
 9- 6-72  1655  21.1  7975  7.55   199   794  3886   .16  87.0  1207    73   507   335    .2   1.3   6989
11- 5-72  1791  18.9  8074  8.20   199   750  3953   .28  86.0  1183    53   440   342    .2 -99.0   6905
 1-16-73  1880  18.9  8088  7.98   195   743  3756-99.00  83.0  1196    67   502   341    .2   1.4   6786
 2- 1-73  1915  18.9  6633  8.23   186   526  3390   .16  73.0   781    56   450   350    .2 -99.0   5718

LG 61 CITY LV TULE 706     19S 60E 04 341 1
 6-16-71   542  22.2   439  8.00   246     8    20   .12   1.8     8     2    41    26    .0    .2    228
10- 4-72  1693  22.2   424  7.79   247     6    21  -.00   2.2     9     1    43    25    .0    .2    230

LG 62 CITY LV TULE 612     19S 60E 09 341 0
10- 4-72  1699  22.2   430  7.76   243     3    31  -.00   1.5     7     1    46    25    .0    .2    234

LG 63 T H GFE  325         20S 61E 16 222 0
10- 5-72  1703  21.7   438  7.87   235     5    39  -.00   2.2     8     2    43    25    .0    .2    240

LG 64 3115  LVBN 300       20S 62E 18 222 0
10- 5-72  1707  21.1   491  7.81   286     5    34  -.00    .9    12     2    24    44    .0   1.0    264
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG 66 NELLIS AFB 350       20S 61E 03 412 0
10- 5-72  1710  20.0   412  7.76   231     5    33  -.00   1.3     9     1    44    23    .0    .2    229

LG 67 3087 W L MEAD 665    20S 61E 20 311
10- 5-72  1712  19.4   519  7.79   234    13    72  -.00   3.0    10     1    55    32    .0    .2    301

LG 68 3001 W L MEAD 309    20S 61E 20 311 0
10- 5-72  1713  20.0   652  7.72    -0    18   134  -.00   6.3    16     2    58    43    .0    .2    277

LG 69 226 ANDERSON  400    20S 61E 20 312 0
10-11-72  1715  21.7   664  7.64   258    14   134  -.00   5.1    16     2    63    42    .0    .2    404

LG 70 1531 W BONANZA440    20S 61E 28 341 0
10-11-72  1717  24.4  9570  7.54  3380    60     1  -.00   6.3    21     3    89    63    .0    .2   1907

LG 71 1823 W CHARLES400    21S 61E 04 211 0
10-11-72  1718  21.1  1390  7.35    12    62   671  -.00   1.1    62     8    71   112    .0    .1    993

LG 72 2040 GOLDRING 425    20S 61E 33 332 0
10-11-72  1720  21.1  1415  7.50   292    73   457  -.00   4.9    80    11    92    95    .0    .2    956

LG 73 1824 GOLDRING 400    20S 61E 33 331 0
10-11-72  1721  21.1  1974  7.70   271    62   316  -.00   3.3    35     5    93    73    .0    .2    720

LG 74 UPRR NO 157' 780     20S 61E 34 232 0
10-12-72  1722  24.4   397  7.67   209     7    37  -.00   1.9     8     2    42    21    .0    .2    221

LG 75 2500 BLDR HWY 400    21S 61E 01 221 0
10-12-72  1724  20.6   335  8.04   165     4    35  -.00   1.6    12     4    23    20    .0    .5    182

LG 76 4200 E RUSSEL 404    21S 62E 29 333 0
10-12-72  1725  23.3   744  7.69   199    11   229  -.00   2.0    29     6    66    39    .0    .4    480

LG 77 3340 ROCHELLE 160    21S 61E 24 114 0
10-13-72  1726  21.7  1039  7.49   242    56   302  -.00   6.0    42     3    98    56    .0    .3    682

LG 78 3369 ROCHELLE 100    21S 61E 24 114 0
10-13-72  1727  21.1  2006  7.40   261   157   741  -.00  11.2   115     5   178   108    .0    .4   1444
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL    SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG 79 5326 TOPAZ           21S 61E 25 312 0
10-13-72  1728  20.0  1120  7.71   161    96    307 -.00   2.7   106     4    86    30    .0    .3    712

LG 80 7117 PARADISE 335    22S 61E 03 441 0
10-13-72  1729  28.9  1269  7.39   196    73    455 -.00   2.7    43    10   148    54    .0    .7    884

LG 81 7044 TOMIYASU 201    22S 61E 01 413 0
10-13-72  1730  25.6  1346  7.41   207   104    437 -.00   2.7    57    15   171    61    .0    .8    950

LG 82 5324 SANDHILL 390    21S 62E 30 422 0
10-17-72  1731  23.3   891  7.45   212    18    358 -.00   2.4    24     6   106    53    .0    .3    672

LG 83 6009 E CHARL  200    21S 62E 03 312
10-20-72  1736  16.7   395  7.48   192     4     47 -.00   1.6    19     4    32    18    .0    .3    222

LG 84 6190 S PEARL  600    21S 62E 31 133
10-20-72  1737  16.7   867  7.83   116    19    377 -.00    .8    23     6    98    49    .0    .3    621

LG 93 CASEY ND SANDHILL    21S 62E 30 241
 1-10-73  1887  22.2 10056  7.75   202    22    368 -.04   2.5    26     6   118    51    .0    .4    693

LG 98 DILLINGHAM 25        21S 62E 08 433
 4-18-73  2026  20.0  2121  7.85   279   137    785-99.00  1.5   112     6   177   126    .1    .3   1482
 5- 9-73  2080  23.3  2030  7.43   284   133    767 -.04    .4   114     7   179   122    .1 -99.0   1462
 9- 6-73  2255  23.3  1822  8.00   257   120    689-99.00   .8    98     2   187   110   5.3 -99.0   1339

LG 99 W W GOLF CRS 26      21S 62E 09 122
 4-18-73  2025  21.1  5302  7.57   409   442   2345-99.00 14.5   422    59   395   356    .3    .9   4275
 5- 9-73  2081  25.6  5001  7.59   198   416   2235 -.04  95.0   403    56   365   352    .3 -99.0   4019
 9- 6-73  2254  21.1  4716  8.09   371   403   2154-99.00 140.0  358    67   335   339    .5 -99.0   3979

LG100 SW 25TH ND ELM 12    20S 61E 35 144
 4-18-73  2023  20.0  3281  7.66   266   121   1646-99.00  2.5   181    20   292   215    .3    .2   2608
 5- 9-73  2079  23.3  2157  7.75   148   116   1525 -.04   1.7   167    18   262   208    .3 -99.0   2371

LG101 BILLMAN 31           21S 62E 21 314
 4-18-73  2027  21.1  9941  7.60   278   807   4975-99.00   .7  1548    93   522   475    .4   1.4   8559
 5- 9-73  2082  26.7  9610  7.46   127   799   5100 -.04  12.4  1571    27   511   467    .4 -99.0   8550

LG102 STIBOREK 20         '21S 61E 02 213
 4-18-73  2022  20.0  5412  7.67   427   280   2808-99.00   .8   447    45   440   372    .2    .4   4603
 5- 9-73  2087  24.4  4492  7.58   208   212   2270  .16    .5   363    26   333   317    .2 -99.0   3624
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4     F  DS-SUM
 9- 7-73  2264  26.7  4261  7.99   409   216  2238-99.00    .4    382    35   300   311    .2 -99.0   3684

LG103 MOTOR VEHCLS 10       21S 62E 01 434
 4-18-73  2021 -99.0  3469  7.64   173   238  1625-99.00   4.4    141    23   433   171    .2    .4   2721
 5- 9-73  2078  23.3  3521  7.74   179   239  1733   .04   8.0    122    23   478   172    .2 -99.0   2863
 9- 6-73  2256  28.9  3704  8.11   215   348  1694-99.00   5.5    237    49   489   150    .5 -99.0   3079

LG104 PETERSON 8            21S 61E 13 223
 4-18-73  2029  16.7  7533  7.67   300   427  3973-99.00    .3    942   169   498   360    .2    .5   6518
 5- 9-73  2086  21.7  6678  7.46   306   408  3645   .04    .8    778   123   517   370    .2 -99.0   5993
 9- 6-73  2260  27.8 59410  7.78   492 12890 31384-99.00 175.0 13975  4560   750  2602   2.1 -99.0  66580
 9- 7-73  2263  26.1 53640  7.85   476  9494 27516-99.00 198.0 11950  3865   717  2416   2.1 -99.0  56392

LG105 JARRETT 36            21S 61E 23 412
 4-18-73  2030  19.4  4877  7.69   240   292  2617-99.00    .0    329    22   534   303    .1    .0   4216
 5- 9-73  2085  22.2  4560  7.37   242   282  2662   .04    .6    299    14   519   308    .1 -99.0   4203
 9- 6-73  2261  21.1  4716  7.83   235   294  2690-99.00    .8    347    32   515   313    .1 -99.0   4307

LG106 ENGELSTAD 46          22S 61E 23 412
 5- 9-73  2083  24.4  3177  7.18   173   203  1620   .04   -.1    111    12   416   194    .0 -99.0   2641
 9- 6-73  2253  22.8  2700  7.94    99   175  1640-99.00   1.8    109     9   362   192    .0 -99.0   2538

LG107 MCSTRAVIK 31          21S 61E 26 332
 4-18-73  2031  21.1  2349  7.65   195   106  1022-99.00    .2    167     9   200   117    .1    .4   1717
 5- 9-73  2084  23.9  2246  7.41   222   100  1004   .04    .3    152    10   217   119    .1 -99.0   1711
 9- 6-73  2252  24.4  2200  8.12   235   107  1012-99.00   3.0    173     9   203   114    .1 -99.0   1737

LG108 W OF I15MILO MY36     21S 61E 08 134
 4-18-73  2020  21.7  3251  7.62   193   129  1733-99.00 [illegible]  87   9   444   187    .4    .3   2718
 5- 9-73  2090  22.2  2658  7.49   190   112  1349  -.04  77.0     58     8   361   163    .4 -99.0   2221
 9- 6-73  2259  21.1  2307  7.95   209   113  1102-99.00  74.0     76     8   336   140    .4 -99.0   1952

LG109 VV AND  OKY 39        21S 61E 05 323
 4-17-73  2033  21.7  2845  7.77   263   189  1192-99.00   1.7    191    12   191   189    .8    .3   2096
 5- 9-73  1520  24.4  2903  7.54   263   187  1237  -.04  66.0    187    12   219   197    .8 -99.0   2235
 9- 6-73  2257  21.1  2864  8.03   258   190  1270-99.00  62.0    203     8   210   203    .8 -99.0   2273

LG110 JOSEPHS  35           20S 61E 33 342
 3- 2-73  1966  25.6  2706  7.67   246   158  1110-99.00   3.3    161    20   117   216    .0    .4   1907
 4-18-73  2032  21.1  2974  7.66   298   181  1275-99.00   2.0    178    24   171   235    .4    .4   2213
 5- 9-73  2088  25.6  2922  7.53   434   172  1210  -.04   2.0    171    22   196   239    .4 -99.0   2226
 9- 6-73  2258  23.9  2763  7.93   378   173  1212-99.00    .3    182    30   204   236    .3 -99.0   2223
10- 4-72    -0    .0     0   .00   378     0     0   .00    .0      0     0     0     0    .0    .0      0
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL    SO4   PO4    NO3     NA      K     CA     MG    NH4      F  DS-SUM

LG112 CURT MANNOZ 312      20S 62E 24 111 1
 5- 8-73  2167  24.4    613  8.03   262    20    74-99.00  11.5     17      2     51     36     .2     .2    342
10- 4-72  1701    .0      0   ..0   262     0     0   .00    .0      0      0      0      0     .0     .0      0

LG113 7000 GILCREAS 560    19S 60E 23 223
 6- 8-73  2135  25.6    416  7.74   239     6    20-99.00   2.9     10      1     39     24     .0     .2    221
10- 4-72  1702    .0      0   .00   239     0     0   .00    .0      0      0      0      0     .0     .0      0

LG114 RNCH SUP CLUB 605    19S 60E 27 112
 6- 8-73  2134  26.7    433  8.04   239     4    26-99.00   2.4      8      1     41     24     .0     .2    224
10- 5-72  1704    .0      0   .00   239     0     0   .00    .0      0      0      0      0     .0     .0      0

LG115 LA PAZ TR PK 200     20S 62E 19 312
 6- 8-73  2138  25.6    398  7.83   200     7    37-99.00   1.8     15      2     24     29     .0     .6    214
10- 5-72  1705    .0      0   .00   200     0     0   .00    .0      0      0      0      0     .0     .0      0

LG116 2342 N PECOS 289     20S 62E 19 222
 6- 8-73  2137  25.9    398  7.82   249     8    48-99.00   1.1     27      4     25     34     .0     .9    271
10- 5-72    -0    .0      0   .00   249     0     0   .00    .0      0      0      0      0     .0     .0      0

LG117 2934 LVBN 300        29S 61E 13 142
 6- 8-73  2139  26.7    549  7.90   251    18    69-99.00   1.9     22      2     36      3     .0     .7    275
10- 5-72  1709    .0      0   .00   251     0     0   .00    .0      0      0      0      0     .0     .0      0

LG118 NELLIS AFB 1 800     20S 61E 19 441
 5- 8-73   500  26.7    519  7.89   243     8    29-99.00   3.3     18      3     35     25     .0     .6    241
10- 5-72  1711    .0      0   .00   243     0     0   .00    .0      0      0      0      0     .0     .0      0

LG119 4434 CRAIG RD 900    20S 61E 04 144
 5-12-73  2145  25.0    384  7.68   193     4    38-99.00    .6     18      3     32     19     .0     .6    210
10- 6-72  1714    .0      0   .00   193     0     0   .00    .0      0      0      0      0     .0     .0      0

LG120 DAY DREAM RANCH      22S 61E 12 222
 6-12-73  2146  99.0   1016  7.46   205    26   365-99.00   3.2     23      6    120     51     .0     .5    696
10-11-72  1716    .0      0   .00   205     0     0   .00    .0      0      0      0      0     .0     .0      0

LG121 CLU9 95  295         20S 61E 19 442
 5- 8-73  2133  28.9    434  7.80   235     4    36-99.00   -.0      7      2     49     22     .0     .2    234
10-11-72  1719    .0      0   .00   235     0     0   .00    .0      0      0      0      0     .0     .0      0

LG122 716 SHADOW L 226     20S 61E 33 331
 6- 8-73  2132  26.7    438  7.93   225     4    46-99.00   2.0      7      2     44     26     .1     .3    243
10-12-72  1723    .0      0   .00   225     0     0   .00    .0      0      0      0      0     .0     .0      0
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LG123 1201 FREMONT 460      20S 61E 35 322
 6- 8-73  2144  25.6    413  7.60   204     5    46-99.00   1.9     9     3    42    23    .0    .3     230
10-19-72  1732    .0      0   .00   204     0     0   .00    .0     0     0     0     0    .0    .0       0

LG124 MICHELAS 1 650        21S 61E 04 413
 6-11-73  2143  26.1    529  7.71   220     8    90-99.00   2.4    10     3    54    29    .0    .3     304
10-19-72  1733    .0      0   .00   220     0     0   .00    .0     0     0     0     0    .0    .0       0

LG125 MICHELAS 2 810        21S 61E 04 413
 5-11-73  2142  25.6    469  7.91   222     6    61-99.00   2.1     9     2    49    25    .0    .2     264
10-20-72  1734    .0      0   .00   222     0     0   .00    .0     0     0     0     0    .0    .0       0

LG126 NLV AIR TERM 500      20S 61E 18 233
 6-18-73  2140  26.7    420  7.86   234     4    29-99.00   2.0     7     1    47    22    .0    .2     227
10-20-72  1735    .0      0   .00   234     0     0   .00    .0     0     0     0     0    .0    .0       0

LG127 LORNZI  PK  680       20S 61E 18 233
 6-18-73  2141  26.7    443  7.82   233     5    40-99.00   2.5     7     2    49    23    .0    .2     243

LG128 AK LOS FARM 30        21S 62E 15 332
 4-11-73  2026  17.8   5551  8.05   336   558  1999  8.83  91.0   716   104   326   159    .0    .9    4128

LG129 LV EXPWY ND VV 10     20S 61E 30 442
 2- 5-73  1924  19.4   1170  7.87   239    67   314-99.00   9.3    79     6    88    53    .0    .3     733

LG132 MELODY ND CYP 5       28S 60E 19 431
 7-18-73  2149 -99.0   4569  7.27   582   226  2228-99.00   1.4   297    68   344   356    .1    .8    3799

LG135 2100 BLEDSOE 215      20S 62E 21 341
11-22-72  1823 -99.0    555  8.42   307    12    52-99.00   -.0    26    12    29    49    .0    .8     332

LG136 3102 ALOHA 100        21S 62E 08 431
11-22-72  1821 -99.0   2904  8.22   187   281  1184-99.00    .3    95    12   248   215    .0    .6    2128

LG137 3208 S. TOPAZ 375     21S 61E 12 342
11-22-72  1821 -99.0    510  8.52   216    17    74-99.00   2.4    11     2    49    30    .0    .3     292

LG139 2832 MD. PKWY 6       21S 61E 10 144
 2- 6-73  1925  13.3   3806  7.85   162   182  1976-99.00  40.0   225    55   316   276    .0    .3    3150
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F DS-SUM

LG139 1859 SYCAMORE 17       20S 61E 19 422
  7-18-73  2150 -99.0   1982  7.65   383   138   519-99.00  52.0   154    25    92   107    .2    .3   1276

LG140 6261 WITTIG 208        19S 60E 23 112
  7-18-73  2148 -99.0   1556  7.77   268    69   230-99.00 370.0    26     7   159    85    .0    .2   1078

LG150 1 MI E LK MEAD DR      22S 63E 04 341 1
  8-15-75    -0   -.0   1177  7.90   256   119   288   .10   5.5   169    12    39    16    .0    .0    774

LG151 BESIDE LG007           21S 63E 28 131 3
  8-15-75    -0   -.0   6610  7.43   234  1135  1995   .67   -.5   671    91   553   232    .0   -.0   4793

LG152 1/2 MI W HEND STP      21S 62E 35 411 1
  8-15-75    -0   -.0   3201  8.01   226   535   719  5.68    .3   408    20   193    69    .0   -.0   2053

LG153 .5 MI S SUNSET RD      22S 62E 03 333 1
  9-15-75    -0   -.0   1198  8.32   242    58   296   .61    .3    22    12    22     9    .0   -.0    538

LW  1 LAS VEGAS WASH 1       21S 62E 23 231 1
  6- 6-70    84  27.5   1136  6.90   240   116   177 31.80  41.2   120    13    70    40    .0    .9    728
  7- 7-70   112  27.5   2010  7.75   451   230   316 33.75   1.1   202    21   110    58    .0   1.0   1194
  8- 6-70   148  30.6   1041  7.86   180   114   160 17.75  46.1    98    14    70    37    .0    .8    646
  9-11-70   202  28.6   1530  7.12   191   188   279 22.38  54.5   150    16    97    49    .0    .9    952
  9-11-70   203  28.6   1646  7.07   181   194   327 27.50  70.4   169    17    92    50    .0    .9   1037
 12-15-70   304  99.9   2146  7.51   208   284   601 20.10  87.5   300    17   117    82    .0   1.0   1612
  1-19-71   333  20.0   2070  7.54   163   280   396 19.10  10.1   187    18   112    61  21.0    .9   1185
  2-18-71   366  21.1   1707  7.34   287   243   283 19.40  11.5   178    18   103    52  25.1   1.0   1075
  4-22-71   445  24.4   1753  7.20   296   232   262 20.80   5.6   208    16    77    55  17.8    .9   1041
  6-11-71   522  28.0   1764  7.35   293   305   317 22.80   7.3   199    16    99    57  18.0    .8   1186
  7-26-71   649  30.0   2025  7.45   275   276   384 23.20   8.4   217    16   102    56  14.4    .5   1233
  8-30-71   724  30.0   2086  7.30   276   275   331 19.50   7.4   208    16    95    51  21.0    .7   1160
 10- 1-71   802  25.0   1813  7.23   291   261   248 19.50   5.4   202    14    85    41  25.9    .7   1046
 11-10-71   840  22.8   1891  7.29   298   260   250 19.70   3.2   197    13    84    42  32.0   1.1   1049
 12- 1-71   897  20.5   1764  7.13   265   245   331 20.00   2.8   195    15    93    50  21.0    .9   1105
  1- 3-72  1035  16.9   1898  7.72   261   256   360 19.70   2.3   200    20   100    53  20.0    .3   1160
  4- 5-72  1344  25.6   1791  7.15   282   293   277 17.20  10.0   198    15    97    54  19.0   1.2   1120
  5- 4-72  1379  23.5   2230  7.28   265   262   567 21.00   8.7   246    17   119    70  18.0   1.0   1460
  6- 1-72  1450  26.7   2074  7.18   225   256   500 22.00   7.9   232    15   122    62  14.0   1.3   1342
  7-10-72  1532 -99.9   2198  6.80   305   268   473 20.00   9.0   267    15   100    57  24.0   1.5   1385
  8- 6-72  1623  30.0   1876  7.07   131   264   318 12.70   6.6   175    12    99    50    .1    .5   1002
 10- 1-72  1695  27.8   1810  7.25   296   252   300 23.00   2.3   209    14    84    41  28.0   1.7   1101
 12- 4-72  1829  18.9   1635  7.29   254   188   337 23.00   1.8   165    14    82    45  17.0    .4    999
  1- 5-73  1865 -99.0   1625  7.32   241   169   312 28.00   2.3   163    15    79    39  23.0   1.4    950
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA    K    CA    MG   NH4     F  DS-SUM

LW  2 LAS VEGAS WASH 2      21S 62E 23 424 1
 6- 6-70    85  26.9  1425  6.85   220   149   307 30.70  46.5   156   15    84    52    .0    .9    969
 7- 7-70   113  28.6  1718  6.85   192   197   456 25.60  54.9   180   16   174    64    .0    .8   1213
 8- 6-70   149  30.3  1302  7.83   183   151   304 13.50  43.4   126   16    75    51    .0    .8    870
 9-11-70   204  28.3  1668  7.22   190   193   349 22.80  54.3   192   17   100    63    .0    .9   1085
 9-11-70   205  28.3  1672  7.35   180   164   388 25.80  67.9   183   18    97    51    .0   1.0   1084
12-15-70   305 -99.9  2154  7.55   196   264   603 21.00  81.5   244   36   120    79    .0   1.0   1546
 1-19-71   334  20.6  2120  7.45   159   279   473 18.30  11.6   204   17   127    81  15.7    .8   1306
 3-11-71   376  19.0  1737  7.50   321   164   414 24.80   3.0   173   21   123    63  15.7   1.0   1160
 4-22-71   446  23.9  1768  7.27   209   242   269 20.80   4.5   222   17    78    53  18.0    .9   1067
 6-11-71   521  28.0  2243  7.32   291   326   322 23.20   6.5   228   16   101    57  17.5    .8   1241
 7-26-71   650  30.0  1985  7.20   281   266   390 23.00   6.9   210   16   103    56  14.7    .4   1224
 9-10-71   725  30.0  2597  7.45   270   281   346 19.50   6.2   213   16    99    53  19.8    .6   1187
10- 1-71   801  24.4  2003  7.42   269   278   354 18.70   2.3   225   16   102    51  25.1    .6   1205
11-10-71   841  22.2  2143  7.26   291   284   341 19.30   1.8   222   17    99    51  30.0    .8   1209
12- 1-71   896  20.5  1784  7.13   269   218   329 20.50   2.0   185   15    92    43  19.0   1.0   1057
 1- 3-72  1034  16.9  1755  7.31   275   218   368 22.80   1.4   181   16    93    53  21.0    .4   1110
 2- 1-72  1169  18.0  2213  7.19   265   292   514 18.40   2.3   251   17   170    69  21.0   1.1   1436
 3- 2-72  1257  18.3  2358  7.19   294   276   664 24.00   7.9   264   20   153    82  27.0   1.1   1663
 5- 4-72  1377  22.5  2657  7.37   298   299   760 21.00  11.5   302   21   157    85  21.0    .9   1825
 6- 1-72  1449  25.0  2054  7.20   238   241   529 23.00   7.2   235   15   118    64  16.0   1.4   1366
 7-10-72  2326 -99.9  2326  6.78   288   303   509 18.20   7.0   254   17   112    62  21.0   1.3   1446
 9- 6-72  1622  30.0  2247  7.06   144   264   525 14.50   6.3   222   15   123    66  15.0    .4   1323
10- 1-72  1696  26.7  2134  7.25   296   283   446 22.00   2.5    11    8   110    55  25.5   1.3   1102
10- 2-73  2272  26.7  2050  9.11   151   279   395 18.00  14.0   216   14   117    54  25.5   -.0   1287
11- 1-73  2282 -99.0  2599  8.26   113   249   348 21.00   2.6   203   13    93    47  25.5   -.0   1058
12- 4-73  2298 -99.0  1819  7.72   108   312   412 19.00   4.1   236   15   100    57  25.5   -.0   1234
 1- 2-74  2213  13.3  1684  7.68   112   297   462 16.00   2.8   229   14   111    58  25.5   -.0   1270
 3- 2-74  2326  20.0  2387  7.27   119   349   515 18.50   3.0   274   17   134    68    .1   -.0   1437
 4- 4-74  2332  19.4  1949  7.81   176   224   475 37.00   2.2   222   17   109    58  18.7   -.0   1258
 5- 8-74  2339  26.1  2275  7.01   260   307   464 20.30   2.3   248   18   132    65  22.8   -.0   1407
 6- 5-74  2352  28.3  1871  7.27   162   243   421 21.00   5.0   233   14    95    51  22.8   -.0   1185
 7- 2-74  2357  26.1  1815  7.87   180   202   411 26.00   2.5   209   18    99    50  22.8   -.0   1130
 8- 2-74  2365  30.0  2139  7.06   164   302   396 17.40   6.0   233   15   110    55  22.8   -.0   1239
 9- 4-74  2372  29.4  1949  6.99   262   277   413 18.90    .6   217   15   114    57  22.8   -.0   1265
10- 3-74  2375  26.7  1921  6.86   156   256   392 16.40   8.0   288   16   113    50  22.8   -.0   1152
11- 6-74  2383  23.3  1972  6.64   217   261   365 17.50  12.0   216   15   102    54  22.8   -.0   1173
12- 4-74  2387  18.9  1583  7.41   307   174   335 25.00   7.0   223   16    93    48  22.8   -.0   1096
 2- 6-75  2397  17.8  2168  7.39   214   302   442 18.36   4.0   241   15   106    59  22.8   -.0   1315
 3- 7-75  2403  21.1  2215  6.76   207   281   470 22.00   2.0   228   17   119    60  22.8   -.0   1324
 4- 3-75  2413  21.1  2458  6.80   235   345   570 17.50   8.0   257   19   144    74  22.8   -.0   1573
 6- 3-75  2425  26.7  2442  9.80   150   322   536 21.20  10.3   264   23   115    71  22.8   -.0   1460
 7- 1-75  2431  27.8  2086  6.30   142   302   392 20.10  10.0   223   16   106    51  22.8   -.0   1212
 8- 5-75  2437 -99.9  2026  6.15   149   290   393-99.00  10.5   221   16   100    53  22.8   -.0   1186
 9- 4-75  2438  27.8  1742  6.72   176   206   382-99.00  60.0   182   13    99    50  22.8   -.0   1102
10- 7-75  2447  23.9  1935  6.43   143   264   366-99.00  13.0   227   15    99    68  22.8   -.0   1125
11- 6-75  2449  20.5  2189  6.90   107   392   427 21.50   6.2   233   15   108    53  22.8   -.0   1242
12- 3-75  2455  21.1  2188  6.40   188   301   416 21.10   4.5   238   14   104    52  22.8   -.0   1223
12-30-75  2461  20.0  2109  6.60   155   309   393 19.00   3.0   230   15   108    54  22.8   -.0   1230
 2- 3-76  2466  21.0  1931  7.34    95   275   388 20.60   2.5   229   13    89    52  22.8   -.0   1149
 3- 4-76  2467  17.0  1992  7.60   137   254   444 18.50   2.8   192   15   106    65  22.8   -.0   1208
 4- 1-76  2472  25.0  2144  6.83   111   293   452 17.98   4.5   245   14   110    51  22.8   -.0   1266
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND     PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4     F  DS-SUM


LW  3 LAS VEGAS WASH 3      21S 63E 30 361 1
 2-20-70     5 -99.9   3190  7.56   117   773   882 27.50  40.8    563    30   229   101    .0   1.1   2785
 3-31-70    22  15.5   4764  7.61   237   800  1102 16.79  31.2    595    28   290   121    .0   1.4   3102
 5- 5-70    51  15.8   4622  7.49   270   823  1152 19.10  12.9    590    29   300   140    .0   1.4   3200
 6- 5-70    87  21.4   4282  7.75   289   910  1175 19.90  11.1    688    34   340   135    .0   1.5   3457
 7- 7-70   114  22.2   3378  7.75   332   665   923 26.00  17.3    466    28   232   112    .0   1.3   2634
 8- 6-70   151  24.4   3198  8.00   259   632   868 12.75  29.2    442    37   240   100    .0   1.2   2490
 9-10-70   174  20.5   3645  7.63   277   768   958 16.75  22.1    556    30   280   105    .0   1.3   2854
 9-10-70   175  20.6   4454  7.87   250   866  1007 18.30  19.5    601    33   280   115    .0   1.4   3064
12-15-70   306 -99.9   3533  7.58   224   555  1085 18.90  37.2    464    28   230   120    .0   1.3   2649
 1-19-71   335   9.4   3212  7.48   236   448   900 21.00  37.2    366    28   232   103    .0   1.1   2253
 2-17-71   367  12.2   3379  7.57   228   563   879 21.00  33.4    434    32   253   100   2.5   1.5   2433
 3-11-71   375   9.5   3969  7.58   254   643  1131 20.00  36.6    483    32   300   119   2.5   1.5   2893
 3-30-71   407  13.3   3878  7.80   250   585   985 20.20  23.5    464    29   255   107    .1   1.4   2593
 3-30-71   413  14.4   3920  7.79   259   600  1017 14.00  23.5    470    29   257   112    .1   1.4   2651
 4-22-71   444 -99.9   3436  7.70   248   520   894 20.10  26.7    441    25   227   102    .1   1.4   2379
 6-11-71   519  18.0   4031  7.85   303   577   943 21.70   9.2    430    25   250   103   8.0   1.4   2517
 7- 7-71   623 -99.9   5516  8.00   296   894  1511 13.90   2.7    645    34   381   142    .4   1.6   3771
 7- 7-71   626 -99.9   5350  8.05   287   871  1427 14.70   4.2    620    32   355   137    .4   1.6   3604
 7- 7-71   629 -99.9   5126  8.00   285   816  1358 15.00   4.7    590    32   337   133    .5   1.5   3426
 7-26-71   640  22.2   3148  7.54   281   411   889 22.60  16.6    360    24   226    96    .8   1.2   2184
 8-30-71   708  21.7   4225  7.62   268   556   997 17.20  15.3    449    35   246   107    .4   1.3   2556
10- 1-71   800  13.9   3248  7.60   254   456   836 18.70  25.0    384    28   220    92   1.2   1.3   2195
11-10-71   826   9.4   3572  7.51   215   443   907 18.80  40.0    392    28   236   101   1.6   1.1   2314
12- 1-71   930  11.5   3091  7.08   206   420   794 21.20  33.0    344    26   206    93   3.3   1.0   2048
 1- 3-72  1033   8.1   3284  7.26   220   465   876 19.60  40.0    365    28   209    93   4.3   1.1   2210
 2- 1-72  1166  39.2   3447  7.55   202   440   979 19.10  45.0    382    30   210   106   4.0   1.1   2331
 3- 2-72  1255   9.3   3864  7.73   231   584  1193 18.30  23.0    493    31   257   125    .4   1.3   2840
 4- 5-72  1343  18.3   3174  7.42   248   442   951 21.00  16.2    394    24   218   102    .8   1.3   2292
 5- 4-72  1375  15.5   3429  7.60   263   460  1014 23.00  10.5    428    22   237   107    .1   1.3   2440
 6- 1-72  1445  22.2   3259  7.30   245   433   964 27.00  11.4    399    32   215   108   5.3   1.3   2316
 7-10-72  1539  23.0   3544  7.78   261   461   993 19.80  16.7    404    25   222    99    .2   1.3   2370
 8- 6-72  1621  23.3   3491  7.67   263   437   895 21.00  16.3    388    26   216   100   1.3   1.2   2232
 9- 6-72  1658  22.2   3309  7.36   230   485   899 20.00  13.8    406    44   205    92   5.0   1.3   2284
10- 1-72  1692  20.0   2862  7.60   257   352   857 22.00  24.0    320    26   207    90    .1   1.2   2026
11- 6-72  1787  17.8   3095  7.49   216   402   823 22.00  32.0    350    26   202    89   1.9   1.0   2055
12- 4-72  1830  10.0   2601  7.23   189   302   737 23.00  34.0    278    23   175    82   3.2   1.1   1751
 1- 4-73  1869 -99.0   2535  7.10   175   294   675 23.00  42.0    258    23   167    73   3.2   1.2   1635
 1-31-73  1896   7.8   3108  7.09   182   439   933 21.00  39.0    391    24   198    95   3.0 -99.0   2232
 3- 4-73  1945  11.7   3035  7.50   277   315   816 19.70  24.0    320    22   198    89   1.3 -99.0   1916
 4- 1-73  1962  10.0   3486  7.28   238   474   949 19.00  39.0    415    25   217   102    .2 -99.0   2357
 5- 2-73  1970  16.1   2548  7.03   183   296   744 21.00  12.0    256    22   180    79   3.3 -99.0   1703
 5-31-73  2104  21.1   2820  7.21   233   395   698 25.69  15.5    322    20   179    77  10.0   1.2   1858
 7- 2-73  2126  24.4   3187  7.30   266   427   824 20.00   4.9    375    43   201    89  18.0 -99.0   2134
 8- 1-73  2165  23.3   2753  8.20   260   407   785 21.00   6.7    360    25   191    93  12.0 -99.0   2029
 9- 5-73  2244  21.1   2282  8.20   258   330   681 22.00  16.0    285    23   188    74   2.6 -99.0   1748
10- 2-73  2270  18.9   2801  8.28   133   338   743 12.00  28.0    297    21   172    80   2.6   -.0   1759
11- 1-73  2284 -99.0   2287  8.38   206   342   659 12.80  24.0    298    20   167    68   2.6   -.0   1695
12- 4-73  2296 -99.0   2703  8.17   202   335   701 16.30  29.0    304    22   183    80   2.6   -.0   1773
 1- 2-74  2315   5.6   2703  7.97   181   342   656 25.00  20.0    277    41   152    80   2.6   -.0   1685
 3- 2-74  2328  14.4   2795  7.77   214   356   739 25.00  16.8    308    21   183    81  12.4   -.0   1846
 4- 4-74  2334 -99.0   2897  7.64   232   379   770 22.20  15.7    323    20   176    88   9.5   -.0   1918
 5- 8-74  2340  17.8   2530  7.04   244   296   659 24.60  11.7    270    19   163    79   7.4   -.0   1648
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POINT IDENTIFIER AND LOCATION
NO DA YR  NUMB  TEMP   COND   PH  HCO3    CL   SO4   PO4    NO3     NA     K    CA    MG   NH4     F  DS-SUM
 6- 5-74  2353  20.0   2578  7.66   252   312   697 21.00    8.7    298    19   161    74   7.4   -.0   1722
 7- 2-74  2359  20.0   3013  8.13   252   384   814 16.80    9.4    345    23   204    86   7.4   -.0   2014
 8- 2-74  2363  25.0   2954  6.98   257   390   748 20.20    3.0    342    26   183    84   7.4   -.0   1930
 9- 4-74  2370  23.3   2513  7.65   266   325   658 21.50    5.3    272    18   162    73   7.4   -.0   1673
10- 3-74  2376  20.0   2922  7.55   252   420   688 29.80    8.0    339    40   174    81   7.4   -.0   1911
11- 6-74  2382  13.3   2679  7.35   230   355   656 18.30   17.0    316    23   153    75   7.4   -.0   1734
12- 4-74  2388  11.1   2384  7.38   201   329   580 22.00   26.0    260    29   187    76   7.4   -.0   1662
 2- 6-75  2398  10.0   2938  7.13   178   382   764 21.35   24.3    328    27   174    80   7.4   -.0   1995
 3- 7-75  2404  12.8   2839  6.90   215   378   762 22.00   22.0    320    24   167    84   7.4   -.0   1892
 4- 3-75  2411  13.3   2788  7.03   177   285   964 13.50   21.0    282    29   201    95   7.4   -.0   1985
 6- 3-75  2426  19.7   2543  6.60   229   314   596 26.10    2.9    267    19   153    69   7.4   -.0   1568
 7- 1-75  2432  20.6   2645  6.50   229   331   626 26.10    2.5    281    19   161    72   7.4   -.0   1639
 8- 5-75  2435 -99.0   2532  6.87   263   312   627-99.00   53.0    270    19   167    72   7.4   -.0   1657
 9- 4-75  2440  22.2   2684  6.81   231   350   677-99.00   52.8    297    19   178    77   7.4   -.0   1772
10- 7-75  2445 -99.0   2927  7.00   221   375   734-99.00    6.0    331    22   185    75   7.4   -.0   1844
11- 6-75  2449  15.5   2876  7.70   189   385   739 20.00    8.3    322    21   183    79   7.4   -.0   1858
12- 3-75  2453  15.0   2598  7.30   168   344   658 25.60   10.5    280    19   148    73   7.4   -.0   1678
12-30-75  2459  14.4   2396  6.70   159   329   624 24.00    4.5    275    19   162    69   7.4   -.0   1592
 2- 3-76  2463  14.0   2541  7.48   160   362   668 20.50    3.5    319    21   161    75   7.4   -.0   1716
 3- 4-76  2468  15.0   2866  7.58   172   385   808 14.30   14.4    300    21   183    84   7.4   -.0   1902
 4- 1-76  2473  22.0   2866  7.05   183   389   798 17.45   13.1    336    20   181    80   7.4   -.0   1930

LW  4 LAS VEGAS WASH 4      21S 63E 29 324 1
 6- 6-70    88  21.0   4925  7.80   275  1250  1482 15.60   20.8    856    44   450   172    .0   1.5   4433
 7- 8-70   121  23.3   4577  7.75   302  1025  1135 19.00   21.0    690    44   310   156    .0   1.4   3550
 8- 7-70   152  26.4   3575  8.10   272   762  1049  8.50   16.6    500    42   226   121    .0   1.2   2860
 9-10-70   166  21.7   4612  7.70   266  1090  1085 12.62   28.4    750    43   380   140    .0   1.3   3661
 9-10-70   167  21.7   5698  7.83   262  1015  1326 13.30   26.1    700    44   350   142    .0   1.5   3747
12-15-70   307 -99.9   4946  7.45   217   863  1226 16.80   47.6    508    37   292   129    .0   1.2   3027
 1-19-71   336   9.4   4344  7.56   228   700  1149 19.10   44.4    514    36   324   124    .4   1.2   3024
 2-18-71   381  13.3   3500  7.50   229   572   946 21.50   34.2    468    33   256   106   2.3   1.4   2553
 4-22-71   441  15.0   3471  7.91   257   520   914 19.50   29.6    423    29   237   105    .1   1.3   2401
 6-11-71   514  20.0   5160  7.75   280   816  1264 17.40   25.2    497    38   345   146   5.7   1.3   3293
 7- 7-71   621 -99.9   6688  7.85   253  1234  1701 10.50   39.0    700    59   495   208    .5   1.3   4565
 7- 7-71   624 -99.9   6463  7.90   260  1152  1670 11.20   25.0    720    49   463   177    .6   1.4   4397
 7- 7-71   627 -99.9   6297  8.00   254  1123  1673 11.10   28.6    691    49   479   179    .5   1.4   4360
 7-23-71   634  23.9   5514  7.30   271  1042  1379 15.40   36.4    598    57   399   184    .5   1.1   3846
 8-30-71   706  23.3   6467  7.75   250  1079  1469 11.10   36.4    618    60   418   188    .3   1.1   4024
10- 1-71   797  15.0   4184  7.70   295   684  1076 15.30   32.0    496    38   298   126   1.4   1.2   2803
11-10-71   824  10.0   4676  7.66   214   730  1141 16.00   53.0    501    43   316   139   1.3   1.1   3046
12- 1-71   928  11.0   4054  7.45   203   639   989 17.20   49.0    431    39   284   126   3.0   1.0   2670
 1- 3-72  1011   8.1   3745  7.93   225   582   975 18.50   46.0    415    33   256   112   3.2   1.1   2553
 2- 1-72  1125   4.0   4003  7.45   206   574  1089 18.60   50.0    420    35   272   123   2.6   1.1   2693
 3- 3-72  1252  10.0   4180  7.78   233   655  1270 17.20   29.0    516    37   305   143    .2   1.2   3089
 5- 4-72  1374  16.5   4460  7.74   242   757  1262 18.00   20.0    510    38   320   143    .1   1.2   3197
 6- 1-72  1442  22.2   4976  7.47   243   621  1124 24.00   17.3    464    45   272   136   3.6   1.1   2827
 7-10-72  1528  25.5   4375  7.70   256   670  1185 16.70   19.0    485    36   295   130    .1   1.3   2964
 8- 6-72  1620  25.0   4184  7.73   265   640  1112 16.50   22.0    464    36   249   125    .3   1.2   2837
10- 1-72  1691  21.7   3752  7.65   293   571  1058 17.20   34.0    430    36   272   117    .1   1.2   2660

LW  5 LAS VEGAS WASH 5      21S 63E 29 331 1
 5-21-70    95  17.8   5196  7.75   241  1237  1635 13.90   70.9    720    34   516   202    .0   1.1   4548
 6- 6-71    90  22.2   5373  7.75   235  1380  1584 11.10   62.5    790    33   417   208    .0   1.2   4510
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA    K   CA   MG  NH4    F DS-SUM
 7- 8-70   122  23.4  4879  7.80   228  1175  1260 11.50  44.3   700   63  376  182   .0  1.3  3921
 8- 7-70   154  27.8  3953  9.00   256   886  1079  7.40  73.5   495   60  340  156   .0  1.1  3220
12-15-70   309 -99.9  4609  7.63   215   800  1367 10.70  70.8   576   54  276  155   .0  1.1  3416
 1-19-71   337  10.0  4862  7.60   276   822  1315 14.50  64.0   566   47  389  153   .4  1.1  3482
 2-18-71   382  16.7  4495  7.56   224   802  1242 14.40  66.5   504   55  389  150  1.5  1.2  3336
 4-22-71   437  17.8  4701  7.85   238   822  1292 11.30  61.0   500   59  390  169  1.5  1.0  3424
 5-11-71   513  21.0  6370  7.75   245  1150  1430 12.40  54.2   499   50  501  207  4.1  1.1  4029
 7-23-71   633  25.6  5964  7.60   235  1004  1460 11.70  54.5   591   55  491  214   .4  1.1  3998
 8-30-71   705  24.4  7093  7.92   214  1237  1542  7.00  56.8   617   61  515  219   .1  1.0  4362
10- 1-71   796  17.8  5191  7.87   223   985  1266 11.80  50.0   545   53  416  174  1.6  1.1  3613
11-10-71   821  11.1  5148  7.65   200   911  1281 14.60  53.0   538   49  372  170  1.2  1.0  3489
12- 1-71   926  12.0  4561  7.45   196   764  1078 14.80  53.0   435   45  332  141  2.5   .9  2962
 1- 3-72  1099   8.1  4310  7.49   198   728  1105 14.90  50.0   448   49  309  141  2.2  1.1  2945
 2- 1-72  1159   5.0  4477  7.55   198   691  1166 15.10  55.0   455   43  320  144  1.7  1.0  2990
 3- 3-72  1249  11.1  4780  7.81   218   876  1382 14.00  34.0   537   50  365  168   .2  1.1  3534
 4- 5-72  1338  20.0  4197  7.62   230   739  1179 15.80  28.0   449   44  326  148   .2  1.1  3043
 5- 4-72  1373  17.0  4898  7.75   237   885  1335 15.40  31.0   545   46  357  162   .1  1.1  3494
 6- 1-72  1441  23.3  4526  7.50   234   781  1226 19.70  25.0   517   53  331  156  3.0  1.1  3228
 7-10-72  1525  27.5  5098  7.87   241   870  1311 11.80  38.5   539   48  368  150   .1  1.2  3448
 8- 6-72  1598  26.1  5227  7.78   242   919  1290 12.50  36.0   555   52  386  157   .2  1.1  3528
10- 1-72  1690  21.7  4782  7.54   238   839  1194 14.10  41.5   520   51  362  147   .1  1.1  3295


LW  6 LAS VEGAS WASH 6      21S 63E 28 112 1
 4- 3-70    30  15.0  5743  7.69   234  1495  1052 13.20  54.5   610   51  475  185   .0  1.3  4043
 5- 5-70    53  18.9  6074  7.90   235  1380  1453  9.95  26.8   696   60  510  220   .0  1.2  4473
 6- 6-70    92  21.6  5196  7.85   262  1130  1686 11.70  48.7   720   34  516  210   .0  1.2  4487
 7- 8-70   124  23.3  5152  7.95   272  1250  1389 11.80  46.5   700   74  426  218   .0  1.2  4249
 8- 7-70   156  26.4  4398  8.20   262  1038  1148  8.23  57.6   515   76  405  174   .0  1.1  3552
 9-10-70   160  20.3  4567  7.84   264  1101  1273  7.12  57.6   643   59  430  176   .0  1.1  3878
 9-10-70   161  20.3  5843  7.99   261   966  1698 11.10  56.5   632   61  433  179   .0  1.3  3952
12-15-70   309 -99.9  4953  7.88   226   845  1517 10.90  72.2   557   56  397  175   .0  1.2  3776
 1-19-71   339   9.4  5146  7.81   236   853  1385 13.50  64.0   578   47  438  167   .1  1.1  3663
 4-22-71   448  15.6  5473  8.02   249   954  1540  8.90  58.0   564   67  473  200   .0  1.1  3996
 5-11-71   511  20.0  6071  7.90   262  1000  1491 10.80  47.4   496   52  494  203  2.3  1.1  3927
 7-23-71   631  22.4  6075  7.82   265  1214  1615 10.20  44.0   619   59  503  217   .3  1.1  4413
 8-30-71   703  22.2  7301  8.05   267  1210  1693  6.60  51.4   647   72  523  233   .8  1.1  4559
10- 1-71   795  16.7  6297  7.74   244  1186  1794  9.80  63.9   655   81  543  241  1.4  1.1  4609
12- 1-71   927  12.0  4764  7.73   216   802  1239 12.80  63.0   467   52  370  161  2.2   .9  3275
 1- 3-72  1005   6.9  4525  7.80   205   700  1213 14.20  56.0   460   51  341  150  1.0  1.0  3102
 2- 1-72  1156   5.0  4756  7.82   209   759  1329 14.40  61.0   490   48  369  157   .2  1.1  3331
 7-10-72  1522  23.0  5791  7.90   265   996  1616  9.00  27.0   612   58  450  183   .1  1.2  4078
12- 4-72  1836  10.6  4411  7.70   289   783  1236 13.60  52.0   506   43  334  165   .1  1.2  3216
 1- 4-73  1866 -99.9  4490  7.46   199   769  1178 16.20  62.9   479   43  323  133  2.0  1.1  3084


LW  7 LAS VEGAS WASH 7      21S 63E 14 411 1
 2-28-70     6 -99.9  3903  7.86   117   995  1363 13.07  41.0   650   40  372  172   .0  1.1  3716
 3-31-70    29  16.9  5676  7.90   237  1415  1787 13.20  53.6   616   50  465  175   .0  1.3  4109
 5- 5-70    57  17.4  6933  7.95   250  1190  1253  9.70  65.2   576   58  490  196   .0  1.2  3980
 6- 6-70    93  27.2  5970  8.00   271  1170  1797  7.50  37.7   696   71  516  205   .0  1.2  4539
 7- 8-70   125  23.9  5111  8.09   296  1140  1579 10.50  44.3   700   67  414  214   .0  1.3  4276
 8- 7-70   157  25.4  4190  8.19   279  1001  1377  5.10  66.4   575   66  455  190   .0  1.1  3874
 9-10-70   158  21.1  4255  7.98   264  1030  1714  9.89  57.6   560   55  440  173   .0  1.2  3659
 9-10-70   159  21.1  5699  7.96   265  1193  1519 10.70  46.7   608   61  440  176   .0  1.3  4086
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMBR  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
12-15-70    310 -99.9   4987  8.02   271   861  1489 11.70  64.6   560    57   386   181    .0   1.2   3709
 1-19-71    339   9.6   4953  7.92   233   810  1606 15.50  96.0   570    46   479   166    .1   1.1   3632
 2-18-71    358  13.3   4871  7.96   246   876  1645 12.70  56.0   646    56   460   172    .6   1.3   3826
 4-22-71    436  15.6   5646  8.11   246   907  1555  8.80  96.5   566    66   460   202    .6   1.1   3960
 6-11-71    510  20.0   5670  7.90   271   966  1660 13.20  36.8   498    69   462   193   2.3   1.2   3787
 7-23-71    630  27.8   5875  7.93   269  1013  1599 10.90  39.6   608    56   495   207    .3   1.1   4161
 9-10-71    752  22.7   6937  8.05   260  1133  1621  8.70  67.0   635    66   500   212    .3   1.1   4345
10- 1-71    796  16.6   5300  7.95   257   987  1673 10.70  43.0   588    60   462   193    .7   1.1   3925
11-10-71    819  16.1   5256  7.90   224   865  1379 12.30  57.0   530    51   390   176   2.6   1.0   3569
12- 1-71    966  11.0   6561  7.76   215   766  1288 16.10  53.0   650    66   356   152   2.2   1.0   3160
 1- 3-72   1005   8.1   6686  7.75   200   721  1196 16.70  52.0   656    68   369   160    .8   1.1   3086
 1-31-72   1216   7.5   6597  7.79   230   766  1256 16.70  92.0   472    67   362   151    .8   1.0   3196
 2- 1-72   1155   6.0   6736  7.69   208   766  1337 13.80  52.0   689    68   366   156    .3   1.2   3309
 3- 3-72   1267  10.0   5053  7.01   266   866  1596 12.60  31.0   553    52   432   177    .1   1.1   3802
 4- 5-72   1336  18.0   6575  7.83   266   786  1373 16.10  30.0   501    67   367   161    .2   1.2   3601
 5- 5-72   1365  16.0   6919  7.99   263   836  1621 15.00  27.0   560    66   403   160    .1   1.2   3587
 6- 1-72   1634  22.2   6072  7.71   260   806  1622 16.20  22.0   553    56   370   166   1.1   1.1   3562
 7-10-72   1571  26.0   5890  7.90   265   999  1665  7.80  27.7   610    59   466   180    .1   1.2   4162
 9- 5-72   1595  26.6   5919  7.89   278   970  1569 10.10  31.0   587    57   467   176    .1   1.2   3976
 9- 6-72   1640  21.1   6051  7.90   252   866  1377 11.70  31.0   533    59   392   158    .1   1.1   3551
10- 1-72   1686  20.0   5056  7.90   262   871  1633 12.50  32.0   562    55   420   165    .1   1.2   3689
11- 6-72   1776  12.2   6952  7.78   232   825  1320 16.00  63.0   506    67   380   152    .1   1.1   3608
12- 4-72   1836  10.6   6503  7.71   215   831  1299 12.30  55.0   520    66   363   156    .1   1.3   3377
 1- 6-73   1865 -99.0   6677  7.50   191   766  1263 16.20  66.0   506    65   336   139   2.0   1.1   3208
 1-31-73   1896   7.2   6651  7.68   196   789  1316 16.20  66.0   525    66   350   168    .2   -.0   3359
 3- 6-73   1983  12.7   6558  7.76   229   837  1311 13.80  66.0   523    66   380   168    .2   -.0   3615
 4- 1-73   2020  12.2   6668  7.06   236   767  1279 13.90  62.0   696    61   370   167    .2   -.0   3273
 5- 2-73   1968  15.6   6151  7.38   183   670  1167 16.90  60.0   650    60   323   131   1.7 -99.0   2910
 5-31-73   2107  24.6   6982  7.21   260   992  1289 16.20  55.0   560    62   380   166    .1   1.1   3696
 7- 2-73   2176  25.0   6176  7.93   295  1166  1700  5.20  56.6   696    89   689   195    .1 -99.0   4690
 8- 1-73   2163  23.9   6690  8.10   277   866  1356 11.80  62.0   563    51   391   170    .1 -99.0   3551
 9- 5-73   2262  21.1   6695  8.60   250   855  1316 10.80  60.0   530    69   386   169    .1 -99.0   3671
10- 3-73   2265  20.0   5895  8.22   236   878  1365  8.00  56.0   565    67   376   156    .1   -.0   3691
11- 1-73   2291 -99.0   6595  8.27   226   798  1181  6.60  23.0   601    60   331   129    .1   -.0   3009
12- 6-73   2298 -99.0   6158  8.15   226   773  1272 10.00  69.0   509    62   352   139    .1   -.0   3156
 1- 2-74   2320   8.9   3767  8.06   207   769  1113 15.20  98.0   668    57   299   136    .1   -.0   2998
 3- 2-74   2330  15.6   6660  7.97   217   728  1261 16.20  96.0   677    60   362   132    .1   -.0   3129
 4- 6-74   2336 -99.0   6668  7.85   263   676  1261 16.70  65.0   662    38   319   160    .1   -.0   3056
 5- 8-74   2365  16.6   6670  7.09   255   699  1266 15.60  36.0   603    39   310   160    .1   -.0   3110
 6- 5-74   2350  21.6   3618  8.16   267   723  1286  8.20  35.0   516    63   366   137    .1   -.0   3220
 7- 1-74   2356  20.6   6808  8.11   275   767  1322 10.30  27.0   522    66   370   169    .1   -.0   3369
 8- 7-74   2361  26.6   6671  7.79   251   669  1201 12.20  36.0   636    66   358   130    .1   -.0   3070
 9- 6-74   2369  23.3   6566  7.97   267   739  1279 10.30  35.0   677    61   362   160    .1   -.0   3211
10- 3-74   2371  18.9   5055  7.66   263   917  1283 16.00  38.0   552    70   339   166    .1   -.0   3517
11- 6-74   2379  12.2   6066  7.72   239   617  1170 13.30  51.0   650    62   300   179    .1   -.0   2060
12- 2-74   2385   8.9   3867  7.56   230   611  1063 15.00  66.0   600    37   289   117    .1   -.0   2692
 2- 6-75   2399   7.8   6106  7.73   207   676  1168 16.60  60.0   636    60   318   120    .1   -.0   2855
 3- 7-75   2605  12.2   6279  7.53   229   655  1192 13.00  69.0   665     5   327   160    .1   -.0   2930
 4- 3-75   2609  11.1   6783  7.11   192   585  1666  9.00  25.0   675    65   302   163    .1   -.0   3165
 6- 3-75   2626  18.9   6676  6.90   266   690  1160 16.50  61.0   661    57   320   125    .1   -.0   2996
 7- 1-75   2638  18.9   6273  6.70   279   673  1118 15.50  30.0   679    56   315   121    .1   -.0   2817
 8- 5-75   2633 -99.0   6710  6.07   263   681  1613-99.00  32.5   669    62   603   139    .1   -.0   3308
 9- 6-75   2662  26.6   6698  7.19   288   671  1345-99.00  38.0   666    39   690   136    .1   -.0   3236
10- 7-75   2663  22.2   6566  7.26   260   667  1260-99.00  76.0   656    62   362   126    .1   -.0   3050
11- 5-75  26670  17.8   6826  7.42   212   603  1179 16.70  53.0   616    57   328   172    .1   -.0   2851
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
12- 3-75  2652  17.8   3876  7.62   179   569  1096 14.80  55.0   395    36   300   112    .1   -.0    2663
12-10-75  2657  11.1   3680  7.40   177   569  1058 15.70  55.0   393    33   300   113    .1   -.0    2625
 2- 3-76  2662  16.0   3557  7.95   173   564  1017 10.50  53.5   460    30   267    98    .1   -.0    2566
 5- 4-76  2671  13.0   4136  7.75   209   616  1307 10.62  43.5   442    37   350   133    .1   -.0    3043
 6- 1-76  2676  21.0   4086  7.50   212   616  1279 11.31  31.5   430    36   350   126    .1   -.0    2927

LW  8 FLAMINGO WASH 1        21S 61E 13 122 1
 4-15-70    33  15.6   3765  7.90   362   650  1603  -.10   -.5   265    28   475   297    .0   1.2    3478
 5- 6-70    62  15.6   3566  7.87   356   361  2004  -.10    .7   306    27   456   280    .0    .9    3586
 6- 6-70    63  19.7   2636  7.90   366   239  1456  -.10   1.2   196    25   262   242    .0    .7    2601
 7- 7-70    97  23.6   2446  7.85   336   270  1263   .20   1.1   170    21   237   266    .0    .8    2373
 8- 6-70   126  25.6   1862  7.80    89    78  1188  -.10   -.5    37    10   470    33    .0    .3    1810
 9-11-70   212  25.6   2646  7.82   303   176  1387  -.10   2.1   135    21   368   171    .0    .7    2392
 9-11-70   213  25.6   3028  7.90   290   206  1396  -.10   -.9   148    23   350   175    .0    .6    2429
12-16-70   317 -99.9   3557  7.61   382   276  2099  -.10    .7   296    36   445   250    .0    .8    3539

LW  9 FLAMINGO WASH 2        21S 61E 13 121 1
 4-15-70    31  16.9   3273  7.62   317   465  1703  -.10   1.8   265    17   395   250    .0    .7    3216
 5- 6-70    37  20.0   2819  7.65   298   235  1603  -.10   3.3   206    17   369   252    .0    .6    2831
 6- 6-70    64  23.3   2741  7.75   276   236  1586  -.10   3.0   201    17   272   238    .0    .5    2683
 7- 7-70    98  20.9   2661  7.75   285   267  1368  -.10   6.0   187    15   290   243    .0    .6    2459
 8- 6-70   127  22.2   2676  7.80   279   259  1677   .13   2.0   188    17   310   265    .0    .6    2782
 9-11-70   214  22.2   2967  7.81   278   267  1497  -.10   7.6   188    17   330   220    .0    .6    2651
 9-11-70   215  22.2   3312  7.85   283   238  1566  -.10   7.2   199    18   326   239    .0    .6    2731
12-16-70   317 -99.9   3518  7.36   348   261  1923  -.10   3.6   250    23   376   266    .0   1.7    3251
 1-19-71   360  12.8   3813  7.51   338   233  1956  -.10   3.7   301    25   356   264    .0    .7    3306
 4-23-71   646  19.6   3579  7.55   317   219  1776   .20   2.8   232    22   373   269    .0    .7    3031
 7-26-71   652  20.6   3629  7.55   285   253  1700   .16   2.9   218    17   368   266    .0    .6    2926
 8-31-71   736  21.8   3882  7.60   303   265  1757   .22   3.1   213    19   365   252    .0    .6    3024
 6- 1-72  1460  19.3   3575  7.39   299   229  1767   .16   3.6   206    20   357   236    .0    .9    2967
 7-10-72  1582  21.1   3960  7.59   303   252  1898  -.06   3.6   215    19   372   251    .1    .6    3161

LW 10 STEVENS SPRING         21S 62E 31 411 1
 4-15-70    32  16.0   7065  7.70   976  1190  2505   .31   -.9   615    65   579   540    .0   3.5    5861
 5- 6-70    61  15.6   6876  7.55   963   715  2655   .25   -.6   660    79   612   540    .0   3.6    5561
 6- 5-70   129  23.3    997  7.60   112    26   469   .28   -.9    25    10   195    20    .0    .3     781

LW 11 UNNAMED SPRING         21S 62E 29 436 1
 3-18-70    17 -99.9   4762  7.50   359   755  2166   .10   -.9   456    55   505   332    .0   2.5    4447
 5- 6-70    65  18.6   5887  7.40   341   901  1956   .10   -.6   466    56   510   336    .0   2.6    4400
 6- 5-70    66  24.2   4190  7.75   365   736  2471  -.10   -.9   520    75   610   366    .0   2.6    4958
 7- 6-70    99  22.9   4216  7.25   370   731  2111   .40   2.9   488    69   562   388    .0   2.5    4353
 8- 5-70   129  23.9   1595  7.80   107    65   980   .10   -.5    33    11    38    25    .0    .3    1195
 9-11-70   106  20.8   4846  7.80   361   790  1906   .30   3.1   438    53   525   300    .0   1.6    4186
 9-11-70   107  20.8   5680  7.06   433   833  2076   .10   -.9   449    56   460   301    .0   1.0    4390
12-16-70   316 -99.9   5380  7.25   352   846  2205   .16   1.1   519    59   498   310    .0    .7    4609
 1-19-71   363 -99.9   6071  7.61   391   787  2419  -.19    .7   570    61   596   360    .0   1.8    4993
 4-29-71   653  17.2   5746  7.36   445   699  2344  1.78    .2   487    62   568   300    .0   2.3    4690
 7-26-71   651  22.8   5636  7.27   421   776  2270   .18    .1   471    52   510   302    .0   1.9    4560
 8-31-71   718  24.9   6872  7.37   457   787  2178   .36   1.3   482    55   553   311    .0   1.7    4593
 5- 4-72  1413  18.3   4271  7.50   376   466  1732   .16    .4   381    39   435   216    .0   1.4    3376
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4    PO4    NO3     NA      K     CA     MG    NH4      F  DS-SUM
 7-10-77  1577  23.1   4356  7.71   386   661  1704    .10    -.1    293     35    420    287     .1    1.0   3291


LW 12 GRAPEVINE SPRING      21S 62E 29 422 1
 4-15-70    34  20.3   2331  7.20   219   336  1082    .12    2.2    120     41    304    150     .0    1.0   2062
 5- 6-70    40  21.1   2208  7.52   217   166  1202   -.10    2.7    126     21    291    150     .0    1.0   2075
 6- 5-70    67  22.2   2116  7.75   222   151  1126   -.10    1.9    136     21    287    147     .0     .9   1978
 7- 6-70   100  20.6   2155  7.75   221   150   997    .25    2.2    121     22    223    150     .0    1.0   1743
 8- 5-70   130  20.0   2173  8.10   228   159  1179   -.10    1.0    120     26    267    152     .0    1.1   2018
 9-11-70   188  20.4   2400  7.84   227   160  1109   -.10    2.4    129     22    275    136     .0     .9   1945
 9-11-70   189  20.0   2545  7.93   225   148  1092    .25    2.2    132     26    272    145     .0    1.0   1927
 6-23-71   456  20.6   2579  7.31   220   159  1165    .16    2.0    166     22    295    146     .0    1.0   2030
 7-26-71   654  22.2   2576  7.61   220   162  1205   -.10    1.7    131     22    277    140     .0    1.0   2060
 8-31-71   731  24.5   2574  7.65   222   162  1147   -.10    1.9    121     26    275    147     .0    1.0   1988
12- 2-71   921  15.0   2656  7.46   225   160  1137    .20    2.1    132     26    296    143     .0    1.0   2086
 1- 4-72  1074  16.9   2595  7.71   221   163  1166   -.10    2.9    127     23    270    141     .0    1.0   1989
 2- 1-72  1180  19.0   2616  7.42   225   163  1139   -.10    2.5    126     21    275    143     .0    1.0   1980
 7-10-77  1576  23.3   2653  7.40   225   161  1171    .12    1.1    123     21    271    146     .1    1.0   2004


LW 13 WHIT. MESA SP. 1      22S 62E 05 141 1
 3-10-70    16 -99.9   5170  7.61   229  1765  1693   -.10    5.1    670     62    560    250     .0    1.2   4877
 5- 6-70    47  26.2   5013  7.83   219  1390  1353   -.10    1.3    516     66    560    246     .0    1.3   4219
 6- 3-70    69  34.4   4427  7.30   231  1270  1736    .11    2.0    590     67    590    292     .0    1.3   4629
 7- 6-70   101  21.0   4138  7.55   216  1100  1216    .15-100.0    490     43    426    270     .0    1.2   3600
 8- 5-70   131  26.6   4763  7.90   183  1366  1617    .21    -.5    500     62    610    290     .0    1.3   4535
 9-11-70   196  25.6   5419  7.39   236  1276  1667    .20     .9    525     53    590    250     .0    1.3   4477
 9-11-70   197  25.6   6503  7.75   239  1263  1836    .16    1.5    500     59    590    246     .0    1.5   4601
 1-19-71   367  13.9   5899  7.80   216  1121  1929   -.10    6.5    632     56    590    263     .0    1.3   4591
 7-26-71   637  23.3   6867  7.75   284  1197  2038   -.10    3.6    670     62    593    291     .0    1.3   4983
 8-31-71   779  26.0   7168  8.05   298  1286  2050   -.10    1.6    664     60    626    296     .0    1.5   5141
11-11-71   819  16.1   6609  7.65   267  1112  1822   -.10    4.3    592     57    510    250     .0    1.2   4496
12- 2-71   920  13.0   5820  7.57   260   917  1841   -.10   17.0    606     59    476    227     .0    1.0   4263
 1- 3-72  1079  15.0   6056  7.76   249  1060  1775   -.10    6.6    566     56    566    265     .0    1.3   4366
 2- 1-72  1181  13.0   5175  7.70   250   993  1757   -.10    6.4    536     53    519    238     .0    1.6   4227
 3- 3-72  1276 -99.0   5632  7.81   243  1069  1753   -.10    6.3    536     57    511    239     .0    1.3   4292
 5- 4-72  1397  20.0   6148  7.68   279  1126  1880   -.06    3.9    586     60    559    255     .0    1.6   4609
 6- 1-72  1460  26.6   6476  7.63   291  1262  1986   -.06    2.6    655     65    569    280     .0    1.6   4966
 7-11-72  1562  21.7   7009  7.70   291  1252  2186   -.06    1.9    630     65    591    282     .0    1.6   5070
 8- 7-72  1637  22.2   6953  7.63   291  1223  1992   -.08    2.6    631     61    549    283     .0    1.6   4928
 9- 7-72  1662  20.0   6566  7.66   307  1269  2100    .08    1.2    647     69    592    293     .0    1.6   5093
10- 1-72  1676  21.1   6676  7.61   307  1250  1955   -.06     .6    670     76    590    283     .0    1.3   4983
11- 7-72  1811  16.1   6658  7.56   296  1166  1888   -.06    1.5    601     61    555    263     .0    1.6   4661
12- 6-72  1863  15.6   6366  7.63   286  1130  1843    .06    3.4    592     59    562    256     .0    1.6   4568
 1- 4-73  1858 -99.0   6177  7.62   270  1001  1827   -.06    6.5    580     57    516    263     .0    1.6   4443
 2- 1-73  1923  16.6  10073  7.29   299  1055  1877   -.06    7.6    566     57    519    260     .0  -99.0   4391
 3- 5-73  2007  16.6   6028  7.86   265  1066  1790   -.06    6.3    557     53    516    238     .0  -99.0   4382
 4- 1-73  1966  16.6   6013  7.81   266  1066  1793    .16    5.1    569     51    527    237     .0  -99.0   4369
 5- 3-73  2036  17.0   6020  7.60   260  1090  1836   -.06    4.3    576     56    538    253     .1  -99.0   4490
 5-31-73  2111  20.0   6676  7.87   299  1266  1996   -.06    3.1    620     59    589    285     .2    1.3   4961
 7- 3-73  2132  29.6   6992  7.76   236  1307  2180   -.06     .0    699     99    589    296     .1  -99.0   5285
 8- 1-73  2183  23.3   6837  7.70   180  1287  2217   -.06    1.4    696      6    606    296     .1  -99.0   5195
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL    SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LW 14 WHIT. MESA SP. 2      22S 62E 04 327 1
 5-19-70    78  17.7   1548  7.40   257   206   409   .13   3.3   120    19   132    72    .0   1.2   1089
 6- 5-70    71  25.6   1548  7.25   265   215   396   .11   2.0   132    21   150    75    .0   1.1   1122
 7- 5-70   102  23.3   1610  7.55   269   220   418   .30   -.5   126    21   156    78    .0   1.2   1153
 8- 5-70   132  25.8   2145  7.39   297   393   439   .33   -.5   166    28   205   101    .0   1.4   1480
 9-12-70   198  23.3   1664  8.00   239   230   329   .15    .4   129    23   140    66    .0   1.1   1036
 9-12-70   199  23.3   1738  8.02   240   273   402   .10   -.9   137    24   130    75    .0   1.3   1118
 1-19-71   341  13.9   4818  7.74   247   895  1246  -.10   2.7   347    66   491   198    .0   1.0   3368

LW 15 WHITNEY MESA SEEP     22S 62E 04 233 1
 3-30-70    15 -99.9   5004  7.60   232  1000  1603  -.10  13.3   553    50   438   227    .0   1.1   4000
 5- 4-70    55  20.0   5500  7.71   225   975  1623  -.10   5.9   586    54   407   214    .0   1.0   3978
 6- 5-70    72  26.5   4157  7.65   232   930  1712  -.10  13.4   656    66   300   236    .0   1.0   4029
 7- 6-70   103  21.7   4237  7.75   232   966  1468  -.10  14.2   602    52   368   234    .0   1.1   3820
 8- 5-70   133  22.5   4318  7.82   203   972  1547  -.10  22.1   625    60   410   220    .0   1.0   3957
 9-11-70   200  23.1   5234  7.81   236   975  1627  -.10  18.6   550    56   440   205    .0   1.1   3988
 9-11-70   201  23.1   5699  7.96   238  1022  1750   .10  13.9   600    64   444   236    .0   1.1   4248
 1-19-71   342  18.3   5699  7.50   214   951  1843  -.10  13.9   603    55   492   222    .0   1.0   4286
 4-22-71   433  20.0   5746  7.27   240   931  1831  -.10  17.4   595    57   429   221    .0   1.1   4201
 6-14-71   541  21.5   5931  7.45   241   946  1796  -.10  14.2   520    57   474   232    .0   1.1   4159
 7-26-71   636  23.9   5714  7.75   246   965  1863  -.10  20.0   585    56   448   229    .0   1.1   4288
 8-31-71   728  24.0   6172  7.95   244   997  1956  -.10  16.0   632    63   471   250    .0   1.2   4506
11-11-71   809  21.1   5831  7.69   239   916  1841  -.10  17.0   596    62   445   232    .0   1.0   4227
12- 2-71   919  13.0   6132  7.62   261  1089  1754  -.10   5.5   594    63   535   250    .0   1.1   4420
 1- 3-72  1069  20.0   5726  7.78   230   915  1820  -.10  20.0   594    59   448   222    .0   1.0   4204
 2- 1-72  1182  13.0   5917  7.63   243   905  1818  -.10  19.0   574    55   449   221    .0   1.1   4162
 3- 3-72  1273 -99.0   5411  7.80   239   917  1812  -.10  19.0   583    57   449   222    .0   1.0   4178
 5- 4-72  1398  21.0   5513  7.66   249   898  1874  -.04  18.0   585    59   459   218    .0   1.0   4235
 6- 1-72  1467  21.1   5466  7.74   247   893  1843   .08  17.9   602    61   444   231    .0   1.1   4214
 7-10-72  5840  23.3   5840  7.79   254   898  1887  -.04  17.0   587    57   452   225    .0   1.1   4249
 8- 7-72  1636  25.6   5899  7.81   253   902  1805  -.04  18.2   569    58   453   225    .0   1.1   4155
 9- 7-72  1661  24.4   5412  7.85   249   893  1903  -.04  16.0   565    58   453   216    .0   1.1   4227
10- 1-72  1678  23.9   5511  7.66   252   894  1830  -.04  18.8   587    60   463   225    .0   1.1   4202
11- 7-72  1812  20.0   5829  7.55   255   889  1719  -.04  19.0   583    58   451   220    .0   1.1   4065
12- 4-72  1844  18.9   5634  7.71   253   889  1791   .08  22.0   587    56   443   222    .0   1.1   4136
 1- 4-73  1859 -99.0   5712  7.62   251   883  1818  -.04  26.0   580    57   440   213    .1   1.2   4141
 2- 1-73  1922  18.3   5537  7.49   251   868  1820  -.04  20.2   565    57   441   213    .1 -99.0   4107
 3- 5-73  2002  18.9   5821  7.84   252   883  1797  -.04  22.0   567    55   456   220    .1 -99.0   4125
 4- 1-73  1963  15.6   5508  7.71   254   878  1802  -.04  22.0   573    54   464   221    .1 -99.0   4131
 5- 3-73  2035 -99.0   5420  7.61   243   874  1799  -.04  21.7   564    56   450   221    .0 -99.0   4106
 5-31-73  2110  21.1   5570  7.88   252   902  1791  -.04  21.0   570    53   454   227    .1   1.1   4143
 7- 2-73  2133  25.6   5544  7.84   236   886  1846  -.04  22.0   575    81   429   225    .1 -99.0   4181
 8- 1-73  2181 -99.0   5406  7.87   188  1157  1864  -.04  21.0   611    53   445   236    .1 -99.0   4479

LW 16 CLARK STP OUTFALL     21S 62E 27 342 1
 3-30-70    16 -99.9   4887  6.80   107  1200  1303  1.53  36.3   675    46   338   142    .0   1.3   3795
 5- 4-70    57  15.5   4805  5.75    25   952  1353  1.14  53.2   634    50   344   130    .0   1.2   3531
 6- 6-70    73  21.1   4241  6.50    73   980  1431  3.38  34.1   798    63   270   176    .0   1.2   3742
 7- 6-70   104  24.4   3418  6.95   114   825  1115  3.30  13.7   520    44   290    86    .0    .8   2954
 8- 5-70   134  25.8   1624  7.99   120    40   968   .38   1.5    52    16   390    27    .0    .2   1554
 9-11-70   190  22.2   4507  7.00    82   831  1337   .70  43.9   575    50   380    95    .0    .9   3354
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMB   TEMP   COND     PH  HCO3     CL   SO4   PO4    NO3     NA     K    CA    MG   NH4      F  DS-SUM
 9-11-70    191   22.2   4953   7.18    88    882  1420   .92   40.9    542    57   378   103    .0    1.0   3468
12-15-70    315  -99.9   5955   7.29    17   1181  1723   .69   85.0    765    67   374   178    .0    1.2   4383
 1-19-71    344   34.4   5579   7.22     8   1149  1770  1.44   27.5    786    54   430   159  10.7    1.3   4393
 3-10-71    416  -99.9   5183   6.98   107    916  1379  2.24    3.0    600    57   323   147  10.7    1.5   3492
 3-30-71    410   24.4   4687   7.06   106    888  1335  3.66   23.0    587    57   310   139  10.7    1.5   3407
 4-22-71    452   30.0   4056   7.27    47    775   978  1.76   16.8    476    47   260    97  10.7    1.1   2686
 6-11-71    527   38.0   4336   6.95    71    721  1066  1.90   13.2    456    42   271    81  11.3     .9   2699
 7- 7-71    620  -99.9   6102   6.40    30   1096  1535  1.90   47.9    721    58   409   124  11.3    1.1   4020
 7-26-71    646   39.4   4962   5.74    23    746  1611  4.50   29.3    671    44   334   102  13.6    1.0   3568
 8-30-71    719   42.2   6467   6.79    43    917  1534  2.12  123.0    743    58   374   116   4.4    1.1   3894
 9-28-71    790   33.3   4912   6.28    26    805  1350  2.40   88.0    673    51   308   101   4.4    1.0   3397
11-10-71    835   34.4   5705   6.98    94    939  1550  4.10   22.0    743    55   321   142  21.0    1.2   3845
12- 2-71    910   29.0   4713   6.99    54    783  1195  3.20  116.0    582    44   248   113  21.0     .9   3132
 1- 3-72   1059   30.8   5438   6.83    51   1022  1367  3.40   69.0    683    49   368   135  21.0    1.0   3743
 2- 1-72   1184   32.0   5046   7.20    66    876  1273  3.80  114.0    628    48   292   128  21.0    1.1   3417
 3- 2-72   1263  -99.0   5390   6.70    54   1300   955  4.00   95.0    875    34   246    99  21.0     .8   3656
 4- 6-72   1358   31.7   5395   7.51   116   1050  1461  2.70   39.0    738    56   358   130   8.1    1.2   3902
 5- 3-72   1405   32.2   3126   8.65    32    524   807  3.40    6.4    375    26   205    59   8.4     .5   2030
 6- 1-72   1461   40.0   4802   7.57   163    868  1264  2.20   37.0    673    47   326    87   3.2     .9   3389
 7-10-72   1574   37.8   5444   6.89   183    922  1384   .86   20.5    705    51   318   123   3.0    1.1   3619
 8- 6-72   1629   38.9   6090   6.63    64   1096  1453  4.30  102.0    786    53   392   115   4.0    1.0   4038
 9- 6-72   1659   28.9   6525   7.46   115   1669   913  1.80   13.0   1060    42   275   102   6.6     .6   4139
10- 1-72   1689   37.8   6370   8.04   236   1133  1816  4.20   25.0    931    71   418   157   3.1    1.1   4676
11- 8-72   1813   30.0   7067   8.42   220   1225  1871  3.60   65.0    975    72   474   168   4.8    1.2   4968
12- 4-72   1839   31.7   6662   8.06   296   1160  1836  4.20   17.2    910    70   442   166   3.5    1.3   4755
 1- 4-73   1856  -99.0   3415   9.32    24    565   798  1.10    4.9    412    28   196    74  13.0     .6   2105
 1-31-73   1892   31.1   5027   8.60   112    987  1320  2.40    9.1    695    47   340    97   1.8  -99.0   3474
 3- 4-73   1991   32.8   4928   6.51   126    732  1417  7.30    3.9    610    43   292   131  13.0  -99.0   3312
 4- 1-73   2009   31.1   5649   7.12   240   1122  1181  3.30    4.8    797    41   331   114    .4  -99.0   3712
 5- 2-73   1973   34.4   4721   7.29   214    799  1300  5.50   18.1    624    44   297   126   3.5  -99.0   3322
 6- 1-73   2112   33.3   6168   8.86   260   1007  1991  5.20   14.2    785    52   445   189  14.0    1.5   4631
 7- 2-73   2131   40.6   5065   6.67    63    817  1608  2.40   37.0    641    61   388   124   3.4  -99.0   3713
 8- 1-73   2171  -99.0   5025   4.86     4    944  1668  2.50   13.3    744    51   413   109  14.0  -99.0   3961
10- 2-73   2276   31.1   5003   7.41    74    802  1445   .63    4.5    594    40   386    98  14.0    -.0   3421
11- 1-73   2287  -99.0   6237   7.14    24    970  1633  3.60   30.0    745    49   409   119  14.0    -.0   3984
12- 4-73   2302  -99.0   5198   7.11    86   1160  1732  3.60   97.0    866    59   449   158  14.0    -.0   4581
 1- 2-74   2309   29.4   4179   7.12    86   1027  1369  4.10   41.0    682    44   338   114  14.0    -.0   3676


LW 17 STAUFFER DITCH A      22S 62E 11 413 1
 8- 5-70    135   27.5   3680  11.55    53    722   319   .11    7.8    725     6    18    11    .0     .3   1835
 9-10-70    185   29.4  24651  13.57   -77    681   351  -.10   24.6   3150     7     2     0    .0     .4   4216
 9-30-70    184   29.4  27499  13.12   -77    805   354  -.10   26.4   3224     6    24    10    .0     .3   4450
12-15-70    317  -99.9   2775  11.45   -77    499   406   .13    3.2    585     4     3     1    .0     .3   1581


LW 18 STAUFFER DITCH B      22S 62E 02 143 1
 2-28-70     11  -99.9  10429  12.10   -77    866   401 22.70   12.9   1190     6    66    17    .0     .1   2563
 3-31-70     20   24.0   8316  11.80   -77   1037   501  2.30   20.8   1175     7    33    15    .0     .4   2792
 5- 4-70     44   27.0  20651  12.50   -77   1506   489   .30   10.6   2470     6    20     6    .0     .4   4429
 6- 5-70     75   33.7  12372  12.10   -77   1670   460   .54    1.3     90    11     1     0    .0     .3   2234
 7- 6-70    105   26.2   4530  11.10    50    852   385  -.10   15.7    770    56    50    22    .0     .2   2176
 8- 5-70    136   31.1   9246  12.53   -77   1055   359   .35   19.0   1325     6   105    30    .0     .4   2900
 9-10-70    183   31.7   4344  12.63   -77    523   392  -.10    9.9    830     6     1     0    .0     .3   1762
 9-30-70    182   31.7   3898  12.10   -77    565   396  -.10   15.1    725     1    55    -0    .0     .3   1757
```

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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
12-15-70   316 -99.9  11065  7.36   119  1054  5029   .32  11.6  2382    14   345   172    .0    .2   9866


LW 19 LV BLDG MAT POND     21S 62E 35 414 1
 3-31-70    21  16.5  10140  7.56   207  2600  1002  -.10   -.5  1425    36   475   226    .0   1.6   5868
 5- 4-70    56  19.8   9525  7.67   216  2870  1102   .12   -.4  1510    38   476   228    .0   1.7   6324
 6- 5-70    78  24.6   8631  7.70   208  3040  1373   .11   -.5  1650    40   518   248    .0   1.9   6966
 7- 6-70   106  26.7   6023  7.75   187  1890  1113  -.10   -.5   940    39   449   214    .0   1.3   4778
 8- 5-70   137  26.9   5851  7.94   170  2112  1102  -.10   -.5   900    49   475   226    .0   1.3   4949
 9-10-70   180  28.3   9356  7.63   108  2960  1457  -.10    .4  1700    51   525   218    .0   1.6   6998
 9-10-70   181  28.3  10970  7.77   189  3200  1592   .13   -.9  1612    55   520   237    .0   1.9   7311
12-15-70   318 -99.9   9550  7.78   215  2390  1335   .08   1.0  1451    36   432   187    .0   1.7   5940
 4-23-71   461  21.7   8275  7.48   199  1978  1457   .20    .2  1200    47   460   206    .0   1.4   5398
 5-17-71   469  21.7   9622  7.85   145  2225  1928  -.10    .3  1281    64   575   217    .0   1.3   6363
 7-26-71   645  26.1   8120  7.46   147  1891  1725   .58    .1  1136    49   487   216    .0   1.2   5578
 8-30-71   718  30.0   6770  8.55   141  1283  1296  2.16    .3   799    39   366   157    .0    .6   4013
11-10-71   833  13.3   4938  7.92   281   901   978 13.70   9.6   630    27   262   109   1.7    .6   3071


LW 20 HEND STP GW DRAIN     21S 62E 36 344 1
 7- 8-70   116  24.2   8556  7.50   709  3210  1509  1.03   -.5  1420    44   700   437    .0   1.7   7671
 8- 7-70   138  26.1  16371  7.76   578  3233  1876   .90   -.5  1675    48   700   475    .0   1.5   8294
 9-10-70   176  25.0  12189  7.62   707  3259  1926   .83   -.5  1738    47   750   458    .0   1.5   8520
 9-10-70   177  25.0  12740  7.73   709  3382  2127   .80   -.9  1760    50   720   475    .0   1.6   8865
12-15-70   319 -99.9  13086  6.70   716  3210  2276   .25    .0  1685    49   756   444    .0   1.6   8725
 1-19-71   348  23.9  13250  6.80   668  3327  2176   .97    .6  1720    58   756   467    .0   1.6   8828
 4-23-71   467  23.0  12692  6.85   723  3251  2097   .94    .1  1527    49   810   468    .0   1.8   8560
 6-11-71   530  22.0  13316  6.90   730  3189  2185  1.70    .1  1418    49   803   474    .0   1.8   8473
 7-26-71   643  24.4  12632  6.90   752  3015  2349  1.16    .5  1664    47   796   472    .0   1.7   8707
 8-30-71   716  25.0  13863  7.29   718  3133  2214   .60    .0  1586    49   776   482    .0   1.8   8596
 9-23-71   782  24.0  12630  7.60   703  3171  2183  1.70    .2  1632    51   821   471    .5   1.8   8679
11-10-71   831  24.4  12924  6.86   765  3195  2297  1.20    .2  1630    63   771   482   2.1   1.5   8779
12- 2-71   912  24.0  12467  6.87   714  3220  2251  1.10    .4  1573    48   800   472   1.3   1.7   8720
 1- 3-72  1060  24.0  12393  7.33   718  3151  2297   .24   1.5  1572    41   820   461    .4   1.7   8695
 2- 2-72  1187  24.0  12510  7.15   713  3153  2285  1.10   1.3  1629    56   795   476    .1   1.9   8749
 3- 2-72 11665 -99.0  11665  7.23   686  3115  2311  2.10   1.0  1690    48   761   477    .2   1.8   8655
 5- 4-72  1387  23.0  12088  6.87   711  3164  2297  1.90   2.6  1606    53   835   462    .2   1.8   8733
 7-10-72  1564  23.9  13067  7.32   691  3163  2314  1.02    .8  1607    51   871   471    .1   1.9   8821
11- 8-72  1780  23.3  12793  6.75   656  3274  2329  1.50    .3  1650    55   905   490    .1   1.9   9021
12- 4-72  1833  22.2  12852  7.05   656  3256  2401   .82    .1  1667    54   905   473    .1   2.1   9082
 1- 4-73  1854 -99.0  13141  6.91   658  3399  2330   .70    .5  1575    51   846   487   1.0   2.1   8926
 3- 6-73  1988  23.3  13466  7.09   642  3406  2314  1.10    .8  1672    53   942   489    .1 -99.0   9193
 4- 1-73  2007  22.2  12885  6.92   639  3586  2258   .80    .7  1660    52   940   484    .1 -99.0   9296
 5- 2-73  1972  25.6  13003  6.86   600  3403  2270  1.40    .2  1622    49   925   487    .3 -99.0   9083
 5-31-73  2102  33.3  13152  7.34   619  3668  2212  4.00    .9  1630    51   895   502    .2   1.9   9269
 7- 2-73  2129  26.1  13286  7.51   626  3499  2283   .40    .8  1664    83   846   483    .4 -99.0   9167
 8- 1-73  2169  26.7  12550  7.95   604  3472  2421  2.90    .3  1692    78   910   524    .4 -99.0   9398
 9- 5-73  1148  25.6  12218  8.00   525  3529  2389  1.40    .3  1704    68   891   598    .9 -99.0   9428


LW 21 HEND STP OUTFALL     21S 62E 36 341 1
 7- 8-70   117  25.0   3455  7.20   327   620   803-99.99   -.5   460    22   226   106    .0    .6   2398
 8- 7-70   139  31.1   3387  7.29   177   659   709 33.10   -.5   446    21   234    98    .0    .6   2287
 9-10-70   178  33.3   3310  7.10   188   644   702 12.80    .9   450    20   212    86    .0    .6   2221
 9-10-70   179  33.3   3591  7.13   195   667   785 13.40  52.1   412    21   217    94    .0    .7   2353
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4      F  DS-SUM
12-15-70   328 -99.9   1786  7.44   160   632   504 30.50  18.3    436    19   224    98    .0     .7    2333
 1-19-71   349  21.1   3681  6.96   917   637   201  9.98    .1    410    21   195    85  13.3     .6    2026
 4-23-71   468  14.0   4137  7.46   411   765   786 29.40   3.1    496    24   248 . 111  17.3     .8    2683
 6-11-71   531  27.0   4000  7.40   399   656   725 25.60    .3    414    22   220    95  15.2     .8    2370
 7-26-71   644  26.1   3489  7.37   436   587   676 22.40    .8    430    19   211    86  11.3     .6    2259
 8-30-71   717  25.0   3661  7.62   403   553   619  9.50    .7    409    18   201    81  16.1     .6    2106
11-10-71   832  13.3   3425  7.47   350   535   611 22.00    .2    396    21   190    75  26.0     .5    2047
12- 2-71   913   9.0   3375  7.70   345   556   638 23.80    .7    412    20   201    81  23.0     .6    2126
 1- 3-72  1061  10.0   3078  7.64   344   580   597 24.50    .1    354    16   172    70  31.0     .4    1934
 2- 2-72  1188   9.0   3148  7.62   387   496   570 28.00    .4    359    16   180    73  22.0     .6    1935
 3- 2-72  1265 -99.0   2927  7.38   360   505   580 28.00    .2    358    17   179    73  29.0     .6    1946
 4- 6-72  1357  18.9   3102  7.40   416   544   585 30.00   1.1    382    18   184    76  26.0     .7    2051
 5- 4-72  1388  22.5   3345  7.54   380   578   645 29.00    .2    411    19   202    83  21.0     .6    2175
 6- 1-72  1462  28.3   3341  7.55   392   563   651 28.00    .2    418    19   207    85  16.0     .6    2181
 7-10-72  1569  25.0   3425  7.15   348   534   667 24.00    .2    383    16   198    78  13.0     .6    2096
 8- 6-72  1630  31.1   3140  7.17   364   475   605 25.00    .2    350    15   179    72  19.0     .6    1920
10- 1-72  1677  20.0   2993  7.46   339   492   585 27.00    .2    356    15   178    72   9.6     .5    1903
11- 8-72  1851  14.4   3033  7.47   382   480   584 30.00   1.1    356    16   179    67   9.6     .5    1910
12- 4-72  1832  13.3   3413  7.37   349   575   625 27.00    .2    395    16   190    78  28.0     .6    2106
 1- 4-73  1853 -99.0   3187  7.38   354   491   587 34.00    .5    357    15   182    71  29.0     .6    1941
 3- 4-73  1989  14.4   3728  7.14   372   597   661 29.00    .5    410    15   221    81   5.7  -99.0    2203
 4- 1-73  2008  13.9   3527  7.04   399   604   671 31.00    .3    412    16   223    81  28.0  -99.0    2263
 5- 2-73  1971  22.2   3295  7.18   361   556   611 33.00    .2    371    11   204    88  27.0  -99.0    2071
 5-31-73  2103  26.1   3338  7.16   352   535   605 29.30    .4    366    15   185    74  22.0     .5    2006
 7- 2-73  2130  29.5   3197  7.31   394   508   573 31.00    .4    372    30   199    72  30.0  -99.0    2010
 8- 1-73  2171  28.9   2643  7.63   194   463   583 32.00    .1    358    16   188    63  23.0  -99.0    1822
 9- 5-73  2249  25.6   2551  8.20   303   451   597 29.00    .2    343    14   189    58  15.0  -99.0    1845
10- 2-73  2267  24.4   2761  7.91   115   406   568 13.00   -.5    320    14   175    62  15.0    -.0    1630
11- 1-73  2290 -99.0   2599  8.22   266   395   515 13.00 100.0    313    14   167    60  15.0    -.0    1674
12- 4-73  2292 -99.0   2703  7.72   157   398   510 32.00 101.0    316    15   178    56  15.0    -.0    1690
 1- 2-74  2318   8.3   2599  7.63   134   458   539 31.00    .3    303    13   168    56  15.0    -.0    1640


LW 22 TITANIUM DITCH        225 63E 07 231 1
 7- 8-70   118  26.4   6422  2.15   -77   960   494  -.10 155.0    127     7   108   239    .0     .2    2071
 8- 5-70   140  27.8   7005  2.11   -77  1171   372  1.46 119.6    170     8   110   212    .0     .3    2164
 9-10-70   168  28.9   5588  2.40   -77   297   774   .10   6.6    132    10   105    48    .0     .4    1373
 9-10-70   169  28.9   4309  2.24   -77   308   827   .17   3.9    125    10   108    47    .0     .5    1438
12-15-70   321 -99.9   8548 12.23   -77  1152   498  -.10 256.0   1425     9    19     3    .0     .5    3355
 1-19-71   350  20.6   4862  2.87   -77  1068   524  -.10 119.2    488    16   110   234    .0     .6    2488
 2-18-71   368  24.4   8033  1.98   -77   830  1394  2.97 105.0    276    12   119   168   8.3     .3    2915
 4-23-71   458  25.6   7836  2.12   -77  1173  1677   .32  83.0    647     8   150   272   8.3     .6    3979
 6-11-71   536  29.0   7878 10.45   -77  1896   578  -.10 156.0   1445     8    41    27   8.3     .2    4159
 7-26-71   639  26.1   5293  2.30   -77   665  1005   .14  12.2    517     9   127    43   8.3     .3    2367
 8-30-71   709  26.7   2722  8.62    97   450   386  -.10   7.1    411     6    38    34   8.3     .3    1398
 9-23-71   780  27.0  61571 13.50   -77  6741   647  2.50  39.0  10200    17    24     7   8.3    5.3   17691
11-10-71   829  22.2   7617 11.85   -77  1211   872  -.10  42.0   1510    17     4    -0   1.6     .3    3608
12- 1-71   905  25.0   7747 11.35   -77  1713   754  -.10  19.0   1570     8    89     0   1.8     .3    4155
 1- 3-72  1065  18.1  27705 11.44   -77  8770  1203  -.10  21.0   6560     8    26     1    .7     .3   16590
 1-19-72    -0 -99.0   7979 11.50   -77  2083   669  -.10  11.2   1750     7    51     1    .7     .2    4572
 1-25-72    -0 -99.0  14897 12.37   -77  3370   851   .40   8.6   3128     7    14    -0    .7     .3    7388
 1-27-72    -0 -99.0   9845 11.72   -77  2638   737  2.40   9.5   2218     7    10     1    .7     .3    5644
 1-30-72    -0 -99.0  12577 12.06   -77  3110   794   .38  19.6   2630    23    33     2    .7     .3    6612
 2- 2-72  1194  20.0   4618 10.38   -77  1139   474  -.10  98.0    918    14    48    11    .1     .2    2645
 2- 4-72    -0 -99.0   7669  5.45     5  2096   791  1.00 131.0   1116    41   141   249    .1     .3    4569
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3     NA     K    CA    MG   NH4      F  DS-SUM
 3- 2-72  1268 -99.0  2232  8.84    60   413   439  -.10  11.9    324    12    86    39    .2     .3   1354
 3- 9-72    -9 -99.0 13868 11.10   -77  3925   783  -.10 118.0   3153    26    19     1    .2     .1   8025
 3-11-72    -0 -99.9  9986  7.76    71  2393   998  -.10  56.0   1605    27   164   112    .2     .4   5390
 3-15-72    -0 -99.9  9268  9.15    39  2523   834  -.10 169.0   1667    27    89   208    .2     .4   5537
 3-19-72    -0 -99.9  6869  2.44   -77  1563   872  -.10 148.0    931    10   120   157    .2     .2   3882
 3-23-72    -0 -99.9  8927  2.38   -77  2343   847   .84 155.0   1022    13   196   310    .2     .3   4888
 4- 6-72  1353  21.7 20884  1.32   -77  2965  2349 10.00 113.0   1476    29   193   200    .2     .3   7316
 5- 2-72  1436  26.7 10317  2.27   -77  2873  1048  -.04 279.0   1180     7   145   492    .2     .3   6024
 6- 1-72  1463  26.7  5711  2.48   -77  1434   405   .14 127.0    332     8   143   291   9.4     .4   2769
 7-10-72  1564  25.6  6632  2.30   -77   979   966   .42 162.0    286     5   107   266   9.4     .3   2762
 8- 6-72  1633  27.8  5488  2.40   -77  1080   482  1.40 133.0    191     5   102   278   9.4     .4   2283
 9- 7-72  1664  26.7  9364 11.21   -77  2047  1678  -.04   6.8   2151     9    25    -0   9.4    2.3   5928
10- 2-72  1680  27.8  5238  9.75   172  1278   414 30.00    .9    634    20    78   262   9.4     .5   2883
11- 8-72  1819  23.9  9471  2.30   -77  2146   895  -.04 191.0   1117    12    93   279   9.4     .6   4743
12- 4-72  1835  20.0 12448  2.58   -77  3036   549   .52 157.0   1545     7   118   288   9.4     .6   5694
 1- 4-73  1855 -99.0  5246  8.50    68  1290   412   .18 188.0    592     6   150     6   5.7     .5   2684
 3- 4-73  1990  25.0  9579 13.15   -77 14040  1620  2.00 212.0  16875    23    28    16   5.7  -99.0  32822
 4- 1-73  2004  19.4  9550  1.97   -77  1755   629  1.50  84.0    620     6   104   173   4.4  -99.0   3377
 5-11-73  2109  25.0  5480  2.78   -77  1379   604   .66 117.0    467    39   101   247  12.0     .5   2967
 7- 2-73  2127  29.4  8891  1.76   -77   394  2212  3.30   8.4    379    26   126    48   1.4  -99.0   3198
 8- 1-73  2168  25.6  7628  1.94   -77   902  1225   .60  96.0    194     6   112   250   9.9  -99.0   2796
 9- 5-73  2247  27.8  7968  2.78     8  1208  1324  -.04 142.0    485    13   143   254  54.0  -99.0   3623
10- 2-73  2266  25.6  6455  1.99   -77   764   911   .69    .4    370     8   108    53  54.0    -.0   2270
11- 1-73  2289 -99.0 13514  1.75   -77  1463  1988   .26 198.0    339     9   116   273  54.0    -.0   4460
12- 4-73  2291 -99.0  7692  1.99   -77  1558   757130.00 213.0    359    10   158   330  54.0    -.0   3553
 1- 2-74  2319  16.6 20790  1.28   -77  2963   364 14.00  13.3    323     6   127    53  54.0    -.0   3917
 3- 2-74  2329  23.3 14344  1.82   -77  2875  1138   .06 199.0   1296    11   126   281  15.8    -.0   5942
 4- 4-74  2335 -99.0  6223  3.82   -77  1798   710   .04 147.0    662     8    91   312  19.3    -.0   3649
 5- 8-74  2343 -99.0  4774  2.68   -77  1063   961   .06 128.0    287     7    98   265  13.1    -.0   2422
 6- 5-74  2354  28.9   769  3.36   -77   508   629   .14   7.2    422     5    75    25  13.1    -.0   1677
 7- 2-74  2360  20.0  3974 11.62   197   513   625   .14  38.0    757     7    19     5  13.1    -.0   2065
 8- 2-74  2362  29.4  5735  3.91   -77  1580   589   .06   3.0    545    10   112   286  13.1    -.0   2978
 9- 4-74  2368  29.4 15899 12.55  2757  1547   958  -.02   3.0   2618    15     5    -0  13.1    -.0   6506
10- 3-74  2374  27.8  4448  9.05   112   936   363   .03 250.0    898     9    23    15  13.1    -.0   2555
11- 6-74  2380  25.6 38418  1.12   -77  4909  1117  2.10 290.0   1215    12   211   356  13.1    -.0   8125
12- 2-74  2389  23.3  9149  2.19   -77  1929  1121   .38 277.0    887     8    96   346  13.1    -.0   4678
 2- 6-75  2400  19.4  9119  2.24   -77  2375   303   .41 273.0    515     8    80   502  13.1    -.0   4069
 3- 7-75  2406  20.0 13088  7.05    74  3582  1488   .16 305.0   2440     1    84   384  13.1    -.0   8334
 4- 3-75  2410  20.0  5313  2.20   -77  1498   871   .12  80.0    444     7    98   247  13.1    -.0   3198
 6- 3-75  2423  26.1 47813  1.20   -77  3725  7082  4.00 290.0    913    10   102   406  13.1    -.0  12545
 7- 1-75  2429  25.6 11198  1.98   -77  1200  2113  2.01  59.0    572     9   153   209  13.1    -.0   4341
 8- 5-75  2434 -99.0  7718  2.00   -77  1480   688-99.00 170.0    241    23    99   305  13.1    -.0   2939
 9- 4-75  2441  26.7  7880  2.14   -77  1955   548-99.00 174.0    563    23   100   300  13.1    -.0   3668
10- 7-75  2444  24.4  9922  2.23   -77  2525   439-99.00 322.0    925     7    89   358  13.1    -.0   4678
12- 3-75  2456  22.2  7285  2.30   -77  1760   335   .05 147.0    498     6    93   204  13.1    -.0   3048
12-10-75  2458  24.4  7668  2.51   -77  2175   308  -.02 227.0    428     6    82   409  13.1    -.0   3648
 2- 5-76  2466  19.0 37095  9.00   400 14300   539  -.02 390.0   8420     7    24   333  13.1    -.0  24223
 3- 4-76  2470  18.0 18903  8.30   168  6750   356   .02 305.0   3200     5    68   646  13.1    -.0  11426
 4- 1-76  2475  25.0  3842  2.30   -77   535   281  -.07  19.2    180     4    74    31  13.1    -.0   1137


LW 23 RMI STP OUTFALL        225 63E 07 122 1
 7- 8-70   119  27.5  2071  7.25   342   265   390-99.99-100.0    292    12    84    35    .0     .3   1246
 8- 7-70   141  29.7  1440  7.59   106   146   329 36.88  51.0    168    11    93    35    .0     .4    923
 9-10-70   170  28.3  1463  6.77   102   146   384 19.23  54.0    176    11    92    32    .0     .4    965
```

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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F DS-SUM
 9-10-70   171  28.3  1472  6.79    93   134   386 20.90  64.9   178    12    94    35    .0    .4    971
12-15-70   322 -99.9  1721  7.18    81   193   424 29.70  62.8   193    17    96    75    .0    .4   1091
 1-19-71   351  14.3  1683  7.30    66   156   392 26.20   4.8   179    16   104    38  15.0    .5    965
 6-16-71   540  25.0  1918  7.55   314   160   363 30.10    .6   208    12    87    32  22.3    .6   1078
 9-10-71   710  28.3  1951  7.10   216   197   332 29.20    .9   193    12    83    32  26.4    .5   1012
10- 1-71   781  24.4  1644  7.31   272   163   346 32.80    .3   188    12    99    33  26.0    .6   1034
11-10-71   828  22.0  1744  7.36   249   167   327 34.20    .2   191    13    92    33  28.0    .5    999
12- 2-71   914  18.0  1751  7.53   278   201   329 40.00    .4   197    14    88    34  31.0    .6   1067
 1- 3-72  1064   7.2  1578  7.44   232   163   349 37.00   2.0   186    12    86    32  26.5    .4   1008
 3- 2-72  1267 -99.9  1527  7.33   276   160   335 32.00    .9   178    11    84    32  29.0    .7    990
 4- 6-72  1355  18.9  1505  7.27   270   159   338 19.40   2.1   168    11    89    34  27.0    .7    980
 5- 2-72  1433  24.4  1521  7.21   248   171   338 33.00    .6   175    11    93    32  26.0    .9   1003
 6- 1-72  1463  26.1  1471  7.38   508   161   188 32.00   1.0   199    12    94    37  10.0   1.3    994
 7-10-72  1563  26.1  1643  7.06   299   168   345 21.00    .2   167    11    97    32  16.0    .9   1008
 8- 6-72  1634  29.4  1615  7.08   272   144   357 38.00    .4   176    11    88    32  18.0    .7    997

LW 25 NEV PS DISCHARGE     21S 62E 11 323 1
 3-31-70    27  19.0  3218  7.75   175   432  1453  -.10  41.6   225    22   391   180    .0   1.3   2832
 5- 4-70    56  23.4  2251  7.35   185   124  1303   .10  22.3   180    14   252   153    .0   1.2   2140
 6- 4-70    88  27.4  3077  7.65   138   344  1631   .11  29.9   269    14   233   182    .0   1.1   2572
 7- 7-70   109  31.1  2686  7.75   178   213  1352   .32  23.8   218    17   237   167    .0   1.4   2317
 8- 6-70   144  31.1  2455  7.98   166   172  1297  -.10  20.4   183    16   278   135    .0   1.3   2176
12-15-70   323 -99.9  3313  7.84   177   188  1675  -.10  46.4   216    16   403   165    .0   1.2   2798
 1-19-71   352  17.2  3533  7.25   144   319  1562  -.10  41.0   280    17   366   171    .0   1.1   2820
 3-30-71   403  23.0  3084  7.71   186   189  1397  -.10  30.0   225    19   298   161    .0   1.3   2412
 7- 7-71   616  23.1  3027  7.90   178   138  1399  -.10  13.3   203    14   299   163    .0   1.5   2318
 8-30-71   723  28.9  3431  8.01   152   185  1471  -.10  14.0   221    17   292   166    .0    .9   2442
12- 1-71   894  23.0  2998  7.46   175   191  1417  -.10  27.0   214    19   322   156    .0   1.3   2434
 1- 3-72  1036  14.0  2994  7.67   203   159  1386   .14  19.0   203    12   286   158    .0   1.3   2325
 2- 1-72  1178  15.0  2929  8.04   208   156  1372  -.10  17.0   213    12   272   159    .0   1.4   2301
 5- 4-72  1379  27.0  3874  7.84   182   216  1466   .90  21.0   235    14   309   154    .0   1.4   2509
 7-11-72  1586  32.0  3326  7.99   155   229  1515   .10  23.3   239    17   304   162    .0   1.4   2567

LW 26 SUNRISE STA OUTFL    21S 62E 10 422 1
 3-31-70    28  25.0  3390  6.02    27   640   887  3.10  80.2   382    35   240    86    .0   2.0   2323
 5- 4-70    46  27.8  3943  6.05    21   847   581  3.84 125.0   482    12   234    75    .0   2.1   2293
 6- 4-70    81  33.6  3417  6.45    48   796   664  2.64 153.3   448    43   230    63    .0   1.7   2331
 7- 7-70   109  36.4  3377  6.95    70   692   809  3.16   8.9   496    43   228    78    .0   1.1   2353
 8- 6-70   145  37.8  3217  7.48    66   631   679  4.76 155.1   364    45   250    68    .0   1.2   2230
 9-11-70   208  36.7  3975  6.91    62   753  1059  3.28  82.0   508    47   305    85    .0   1.2   2866
 9-11-70   209  36.7  4240  5.98    60   795  1061  2.37 189.6   544    54   320    94    .0   1.3   3011
12-15-70   324 -99.0  4862  7.11    24   952   932  4.68 187.5   578    52   295   118    .0   2.9   3127
 1-19-71   353  31.1  3419  7.25     3   656   651  6.12 116.2   403    35   288    84   6.4   2.3   2172
 3-30-71   401  20.5  4813  7.03    77   916  1020  7.30 149.0   538    59   296   128   6.4   2.1   3156
 4-22-71   447  10.6  1695  7.61   108   284   295  1.65  21.7   153    28   183    34   6.4    .9    973
 6-11-71   523  26.0  2586 10.00     9   376   538   .20   5.3   308    23   174    23   4.0    .4   1417
 7- 7-71   615  31.9  6444  9.25    53  1230  1415   .28  44.0   984    77   379    79   4.0   2.3   4162
 8-30-71   722  37.8  5685  8.90    34  1042  1035  1.80 113.9   669    59   362    53    .8   1.9   3354
 9-28-71   793 -99.0  3298  7.98    75   636   697   .76  95.0   453    37   284    39    .8    .5   2109
11-10-71   839  31.1  4309  6.92    50   814   969  3.30  94.0   541    45   256    82   5.0   1.7   2733
12- 1-71   899  28.0  5169  6.77    46  1094  1079  4.50 255.0   695    66   360   171   8.0   2.1   3707
 1- 3-72  1037  24.0  5192  6.69    40  1049  1091  4.00 197.0   644    55   360   171   2.0   2.1   3545
 2- 1-72  1171  24.0  4796  7.58    53   934   974  6.70 207.0   583    52   298   110   2.1   2.7   3189
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3     NA      K    CA    MG   NH4      F  DS-SUM
 4- 5-72  1365  35.6  5119  9.74   -77   893  1540  2.00  33.0    911     54   246    74   8.4    2.0    3763
 5- 6-72  1381  28.5  5877  7.93    82  1244  1236  3.60 192.0    830     76   398   119   1.9    3.4    4135
 6- 1-72  1451  34.4  6017  6.85    88   990  1071  4.20 138.0    652     60   312    96   2.2    3.0    3401
 7-10-72  1534 -99.0  4504  7.11    75   836   912  3.80 114.0    578     47   291    59   1.3    2.2    2971
 8- 6-72  1624  37.0  7823  6.97   164  1420  1299  5.20 156.0    920     78   463   109   1.4    2.8    4535
 9- 6-72  1657  31.1  5831  7.01   109  1185  1298  4.80 180.0    806     74   391   116    .9    2.7    4112
10- 1-72  1683  32.2  5208  7.24   101  1047  1134  4.50 171.0    737     63   370    91   3.8    2.4    3673
11- 6-72  1789  27.7  9471 10.10   -77  1561  2728  1.04 197.0   1920     93   378    90   1.8    1.2    6929
12- 4-72  1929  26.7  5490  7.71   264  1036  1369  4.30 124.0    708      6   378   165    .7    3.0    3982
 1- 5-73  1966 -99.0  6332 10.77   -77  1079  1430  -.04 115.0   1210     57   235     6    .7     .7    4133
 1-31-73  1981  25.6  5600  8.27   240  1088  1622  5.00 103.0    771     61   396   164    .7    -.0    4132
 1-31-73  1981  25.6  5500  8.27   240  1098  1622  5.00 103.0    771     61   396   164   1.7    -.0    8392
 3- 4-73  1996  18.3  2403  7.67    95   244   761  -.04   3.9    221     12   134    98   4.5  -99.0    1525
 4- 1-73  2012  13.9  3204  7.30   192   325  1270   .40   2.3    239     15   269   185   4.5    -.0    2413
 5- 2-73  1977  28.9  4456  7.92    64   506  1054   .28   3.4    574     25   229   201    .4  -99.0    3424
 5-10-73  2094  31.1  5978  7.14   425  1217  1188  1.50  15.0    802     73   342   127   2.1    3.7    3981
 7- 2-73  2117  34.4  7992 11.90     0  1172  1493  -.04  12.7   1355     94   260    -8   3.6  -99.0    4390
 8- 1-73  2175  32.2  6997  9.70    40  1534  1701  -.04  64.0   1142    110   443   101   2.6  -99.0    5117
 9- 4-73  2236  31.1  6767 11.11   -77  1276  1921  -.04  92.0   1433     59   297     4   4.0  -99.0    5008
 9- 4-73  2239  36.7  4385  7.60    39   767  1633  3.30  96.0    627     40   404   114   4.0  -99.0    3668
10- 2-73  2273  33.3  6089  7.36    65  1146  1484  3.02 959.0    796     63   446   105   4.0    -.0    4639
11- 1-73  2281 -99.0  5190  7.44    39  1010  1167  6.60  60.0    690     54   397    72   4.0    -.0    3489
12- 4-73  2299 -99.0  5509  7.62    96   938  1365  4.60  95.0    654     59   403   127   4.0    -.0    3678
 1- 2-74  2312   2.2  1362  7.93   160    95   670   .74   6.4     98     18   167    68   4.0    -.0    1157


LW 27 CLARK CO STP EFFL    21S 62E 22 224 1
 3-31-70    18  23.0  2024  7.23   369   190   401 30.00-100.0   215     14   113    63    .0    1.2    1287
 5- 4-70    58  23.4  2441  6.98   273   378   451 10.50   1.6    291     16   125    73    .0     .4    1489
 6- 6-70    83  25.6  1960  6.85   168   336   409 23.80  12.1    245     14   124    68    .0     .9    1315
 7- 7-70   111  27.8  1617  6.90   200   184   391 25.50    .2    160     15   105    58    .0     .8    1037
 8- 6-70   147  28.9  1866  7.88   175   312   420 12.40  92.0    220     17   127    71    .0     .6    1319
 9-11-70   218  28.9  2176  6.90   165   323   413 20.08  14.2    242     18   125    65    .0     .6    1302
 9-11-70   219  28.9  2154  8.69   148   340   437 22.40  53.3    250     20   125    70    .0     .7    1391
12-15-70   330 -99.9  2120  7.56   163   295   377 28.90  71.4    228     16   101    58    .0     .7    1256
 1-19-71   359  22.8  1985  7.39   167   244   404 24.40   2.4    193     17   112    60  17.7     .7    1157
 3-10-71   404  22.0  2200  7.37   312   313   371 18.60   9.9    220     17   112    63  17.3     .6    1296
 4-22-71   450  22.8  1760  7.29   311   208   319 29.70    .7    204     15    89    58  17.1     .8    1096
 6-11-71   525  29.0  2517  7.30   108   363   366 21.50   4.2    236     15   115    59  23.4     .5    1335
 7- 7-71   611  23.8  2597  7.22   247   360   542 15.50  13.6    267     19   145    72  16.1     .6    1572
 7- 7-71   612 -99.9  2441  7.40   200   355   435 17.50   9.3    247     17   131    65  22.3     .7    1437
 8-30-71   720  28.9  2971  7.49   261   357   560 22.40   6.6    292     18   136    70  22.8     .8    1614
10- 1-71   806  26.1  2311  7.52   286   266   544 26.20   4.2    257     19   108    66  23.2     .7    1455
11-10-71   837  25.0  2290  7.33   285   276   483 23.00   3.9    250     14   108    60  28.0     .7    1306
12- 1-71   901  22.0  2331  7.23   310   321   506 19.70   2.5    271     18   130    68  26.0     .6    1515
 1- 3-72  1056  18.0  2432  7.32   274   334   477 17.80   1.9    256     15   127    65  24.5     .5    1456
 2- 1-72  1176  20.0  2252  7.91   288   321   412 18.70    .9    245     15   110    58  33.0     .6    1356
 3- 2-72  1260 -99.0  2442  7.37   286   374   523 18.70   3.0    282     17   127    69  29.0     .5    1504
 4- 5-72  1349  23.9  1894  7.52   316   249   368 26.00   2.1    209     16    95    53  28.0     .8    1182
 5- 2-72  1383  24.0  2449  7.38   297   406   457 11.20   2.5    285     16   131    63  25.0     .5    1543
 6- 1-72  1457  26.1  2340  7.14   299   310   504 19.30   3.5    270     16   130    64  27.0     .6    1512
 7-10-72  1535 -99.0  2178  7.21   281   257   453 27.00   1.3    231     16   108    51  28.0     .9    1304
 8- 6-72  1627  31.1  2468  7.22   311   341   472 18.00   2.0    260     15   119    62  29.0     .7    1672
 9- 6-72  1654  26.7  2155  7.11   127   387   496 16.00   2.3    242     16   119    58  26.0     .6    1345
10- 1-72  1697  28.1  2196  7.32   272   264   475 29.00   3.2    240     16   109    58  27.1     .8    1351
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
11- 6-72  1792  23.3   2208  7.34   275   263   495 36.00   2.0   246    17   116    55  20.0    .8   1385
12- 6-72  1869  20.6   2858  7.45   305   368   695 24.00   5.6   325    19   147    81  29.0    .8   1825
 1- 5-73  1864 -99.0   1583  7.43   219   177   315 23.00   2.0   161    12    78    42  14.0   1.2    933
 3- 6-73  1992  21.1   2382  6.90   329   269   412 29.00    .6   224    15   119    58  31.0 -99.0   1319
 4- 1-73  2010  17.8   2708  7.06   303   388   606 20.00    .6   306    18   153    78  23.0 -99.0   1738
 5- 2-73  1975  24.4   2290  7.05   289   282   489 27.00    .0   238    13   124    58  29.0 -99.0   1482
 5-11-73  2095  26.7   2740  6.74   199   446   566 19.00   1.2   312    17   136    75  33.0    .5   1682
 7- 2-73  2119  28.9   2617  7.17   311   391   513 22.00    .6   298    32   136    65  30.0 -99.0   1640
 8- 1-73  2173  29.4   2082  8.10   136   370   527 17.00   2.6   276    19   150    58  25.0 -99.0   1512
 9- 4-73  2238  28.3   1862  8.60   143   280   519 31.00   1.7   261    18   131    56  24.0 -99.0   1387
10- 3-73  2275  27.8   2426  7.95   122   366   511 27.50    .9   287    17   138    61  24.0   -.0   1471
11- 1-73  2288 -99.0   2100  7.91   140   251   483 29.00   1.5   236    16   109    58  24.0   -.0   1277
12- 4-73  2301 -99.0   2037  7.67   127   285   480 31.00   2.6   241    17   118    61  24.0   -.0   1322
 1- 2-74  2310  18.3   1946  7.50   112   379   569 23.00  99.0   294    17   150    71  24.0   -.0   1681


LW 28 BMI SEEP PARCO RD     21S 63E 31 313 1
 2-26-70    12 -99.9  11000  7.83    39  2760  2725  -.10 173.6  1262    35   815   489    .0    .4   8230
 3-11-70    23  22.0   8772  8.42    67  2506  1503  -.10 265.0   850    40   750   340    .0    .5   6289
 5- 5-70    54  22.2   8092  7.35    75  1903  2504  -.10 194.9   944    47   766   356    .0    .5   6752
 6- 5-70    86  28.1   6565  7.30    66  1810  2248   .10 203.8   950    56   694   368    .0    .5   6355
 7- 8-70   120  23.9   6371  7.50    87  1740  2172   .45 161.7   860    56   562   344    .0    .4   5939
 8- 7-70   150  28.3   6329  7.62    89  1750  2136  -.10 186.1   905    58   775   320    .0    .5   6175
 9-10-70   172  30.0   6353  7.42    84  1501  2169  -.10 150.6   815    58   740   315    .0    .5   5870
 9-10-70   173  30.0   8154  7.38    83  1720  1720  -.10 146.1   852    64   723   305    .0    .5   5571
12-15-70   326 -99.9   8154  8.36    71  1460  2441  -.10 150.0   889    59   784   298    .0    .4   5956
 1-19-71   355  17.8   7806  8.39    77  1430  2631  -.10 144.0   790    58   751   305    .1    .5   5955
 4-23-71   459  19.4   8409  7.28    98  1567  2605   .70 150.0   834    61   713   320    .1    .5   6116


LW 29 GRAVEL PIT DRAIN     21S 63E 29 332 5
 5-21-70    96  21.9   5693  7.75   115  1570  1737   .12 179.4   566    39   725   300    .0    .4   5173
 6- 6-70    89  23.3   5473  7.70   118  1630  1788  -.10 181.6   538    41   736   296    .0    .4   5069
 7- 7-70   115  24.8   5451  7.75   104  1485  1924  -.10 172.0   540    89   650   316    .0    .4   5228
 8- 7-70   153  25.6   5339  7.94   119  1565  1607  -.10 201.6   480    96   700   300    .0    .5   5004
 9-12-70   220  22.5   6063  7.83   165  1590  1374  -.10 221.5   495   112   724   300    .0    .5   4898
 9-12-70   221  22.5   7331  7.80   155  1650  1555  -.10 199.2   621   111   735   295    .0    .5   5543
12-15-70   327 -99.9   7361  7.39   182  1474  1879  -.10 157.0   512   171   695   285    .0    .5   5213
 1-19-71   356  18.9   6709  7.42   198  1319  1875  -.10 146.5   544   117   624   292    .2    .6   5012
 6-11-71   516  22.0   9342  7.75   162  1762  1744  -.10 134.0   520    66   837   351    .2    .8   5495
 7- 7-71   617 -99.9   8299  7.85   154  1907  1598  -.10 129.0   526    82   812   336    .2    .7   5457
 9-23-71   777  20.0   7572  7.75   137  1689  1787  -.10  97.0   623    87   787   307    .2    .8   5285
12- 1-71   979  17.5   7419  7.48   179  1748  1795  -.10 126.0   600   116   792   322    .2    .6   5553
 1- 3-72  1010  11.9   7932  7.58   131  1855  1830  -.10  92.0   614   111   796   378   1.4    .6   5692
 2- 1-72  1160  11.7   8173  7.52   133  1878  1864  -.10  86.0   624   117   790   333   1.4    .7   5759
 3- 2-72  1251  15.0   7896  7.69   125  1925  1882  -.10  76.0   662   129   779   332    .2    .6   5867
 4- 5-72  1339  22.0   9190  7.35   122  1981  1901   .04  78.0   692   129   771   326    .1    .7   5939
 5- 2-72  1429  22.2   8376  7.55   116  1999  1936  -.04  80.0   725   133   793   317    .1    .7   6039
 6- 1-72  1463  23.9   8765  7.16   122  2166  1910  -.04  95.0   836   125   813   317    .2    .7   6310
 7-10-72  7454  29.5   9454  7.77   122  1999  1971  -.04 110.0   895   119   811   299    .2    .8   6265
 8- 6-72  1600  28.3   9130  7.72   143  2116  1895  -.04  93.0   952   111   748   283    .1    .9   6259
 9- 7-72  1666  23.3   8346  7.61   166  1983  1851  -.04  92.0   933   103   736   251    .1    .9   6032
10- 1-72  1682  22.2   9140  7.45   164  1936  1765  -.04  96.0   925    96   782   253    .2    .9   5955
11- 6-72  1783  20.8   9532  7.54   157  1949  1845  -.04 104.0   946    89   742   255    .3    .9   6089
12- 4-72  1839  15.6   8695  7.71   144  1914  1830  -.04  60.0   921    91   742   259    .3    .9   5989
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMB   TEMP   COND     PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 1- 4-73   1948  -99.0   8609   7.58   140  1924  1989  -.04 116.0   896    94   717   258   2.0    .9   5985
 1-31-73   1898   15.6   8124   7.61   139  1913  1853  -.04 127.0   908    91   708   258   2.0 -99.0   5930
 3- 4-73   1984   16.7   9136   7.60   143  1972  1817  -.04 144.0   898    89   742   258    .1 -99.0   5991
 4- 1-73   1965   13.3   9236   7.56   142  1932  1911  -.04 130.0   896    95   752   268    .1 -99.0   6046
 5- 2-73   1969   20.0   9026   7.58   164  1853  1738  -.04 142.0   895    66   717   236    .2 -99.0   5728
 5-11-73   2108   24.4   8320   7.69   152  1875  1979  -.04 157.0   891    93   691   257    .3    .9   6019
 7- 2-73   2125   28.9   7592   7.89   188  1692  1619  -.04 131.0   812    79   636   217    .4 -99.0   5279
 8- 1-73   2164   23.3   7877   7.77   156  1650  1744  -.04 106.0   847    76   684   277    .4 -99.0   5421
 9- 5-73   2243   25.6   6427   8.50   167  1534  1795  -.04  99.0   853    81   636   206    .4 -99.0   5287
10- 2-73   2271   22.2   7500   7.97   189  1490  1876   .17 126.0   812    55   614   221    .4   -.0   5248
12- 4-73   2297  -99.0   8244   8.05   154  1693  1828  -.04 104.0   852    58   681   233    .4   -.0   5525
 1- 2-74   2314   11.1   6231   8.05   151  1693  1920  -.04 102.0   878    60   675   249    .4   -.0   5651
 3- 2-74   2327  -99.0   8180   7.91   158  1724  1814   .06 129.0   831    65   699   247    .4   -.0   5587
 4- 4-74   2333   15.0   8284   7.85   165  1799  1892   .06 136.0   878    68   678   254    .4   -.0   5778
 5- 8-74   2341   23.3   8162   7.61   188  1791  1863   .06 129.0   888    63   643   243    .4   -.0   5713
 6- 5-74   2351   25.0   7277   7.95   201  1758  1789  -.04 114.0   908    68   657   234    .4   -.0   5620
 7- 2-74   2358   21.7   7723   7.98   186  1655  1735  -.04 139.0   885    65   574   221    .4   -.0   5326
 8- 2-74   2364   28.9   7956   7.74   188  1699  1999   .10   1.3   858    65   665   239    .4   -.0   5518
 9- 4-74   2371   26.1   7385   8.05   198  1585  1887  -.02 144.0   830    58   651   231    .4   -.0   5484
10- 3-74   2377   23.9   7582   8.05   193  1643  1835   .10 140.0   888    55   637   233    .4   -.0   5527
11- 6-74   2381   18.9   8897   7.48   175  1604  1849   .10 153.0   915    55   653   243    .4   -.0   5559
12- 4-74   2386   15.6   7517   7.38   167  1643  1783   .10 161.0   794    51   592   237    .4   -.0   5345
 2- 6-75   2401   14.4   7994   7.80   160  1683  1843   .10 141.0   835    47   679   237    .4   -.0   5544
 3- 7-75   2407   16.1   8054   7.20   150  1757  1788   .06 163.0   850     6   627   249    .4   -.0   5514
 4- 3-75   2412   19.4   8151   7.52   145  1925  1775   .11 175.0   904    61   634   268    .4   -.0   5805
 6- 3-75   2422   20.6   8749   5.98   187  1917  1835   .14 165.0   294    64   796   520    .4   -.0   5673
 7- 1-75   2428   20.6   8698   5.70   193  1897  1875   .17 135.0   922    62   737   275    .4   -.0   5999
 8- 5-75   2436  -99.0   8598   6.13   188  2109  1711-99.00 175.0   868   178   678   266    .4   -.0   6070
 9- 4-75   2439   21.7   8629   7.25   210  1764  1537-99.00 173.0   815   178   595   250    .4   -.0   5408
10- 7-75   2446   20.6   8354   6.26   181  1841  1755-99.00 244.0   859    64   657   266    .4   -.0   5776
11- 5-75   2450   20.0   7400   7.29   198  1737  1471   .06 148.0   674    46   453   218    .4   -.0   4941
12- 3-75   2454   19.4   7668   7.49   192  1891  1419   .07 151.0   680    44   475   298    .4   -.0   5053
12-10-75   2458   16.1   8051   7.61   192  2038  1434   .04 151.0   670    43   463   268    .4   -.0   5162
 2- 3-76   2465   18.0   8079   7.25   162  2085  1379   .08 147.0   656    40   662   334    .4   -.0   5383
 3- 4-76   2469   16.0   8588   7.45   158  2312  1474   .01 123.0   750    41   740   381    .4   -.0   5899
 4- 1-76   2474   23.0  10011   6.60   140  2946  1519   .12 143.0   820    45   908   474    .4   -.0   6008

LW 30 POND ADJ LV WASH      21S 63E 28 142 1
 6- 5-70     91   22.5   5846   7.70   230  1383  1990  -.10  59.8   750    38   558   315    .0   1.0   5207
 7- 8-70    123   25.3   5579   7.65   234  1470  1873   .20  64.2   720    85   524   318    .0   1.1   5178
 8- 7-70    155   23.6   5432   7.92   211  1436  1677   .12 119.6   585    90   602   288    .0   1.1   4981
 9-10-70    162   22.8   5573   7.73   239  1445  1736   .15  75.3   615    73   630   288    .0   1.1   4982
 9-10-70    163   22.8   7361   7.75   244  1550  2165   .12  57.3   740    89   635   304    .0   1.1   5662
12-15-70    324  -99.9   7571   7.93   243  1470  2185  -.10  57.0   747    85   640   288    .0   1.1   5593
 1-19-71    357   13.3   7211   7.67   253  1380  2176  -.10  63.6   760    81   996   295    .0   1.1   5483
 4-22-71    436   19.4   7398   7.60   242  1361  2181   .12  64.4   720    77   638   279    .0   1.0   5441
 6-11-71    517   22.0   8063   7.65   251  1367  2179   .14  62.4   747    76   632   292    .0   1.1   5438
 7-23-71    632   25.0   7439   7.23   260  1399  2219  -.10  99.6   779    81   635   292    .0   1.1   5598
 9-10-71    704   23.3   8260   7.15   257  1370  2186   .20  61.0   737    83   652   287    .0   1.1   5426
11-10-71    828   16.1   7758   7.32   253  1380  2110  -.10  95.0   753    80   626   290    .0   1.0   5360
12- 1-71    924   14.0   6720   7.34   260  1761  2092  -.10  73.0   741    85   630   271    .0   1.0   5292
 1- 3-72   1087   11.9   6876   7.57   266  1252  2072  -.10  59.0   675    78   647   260    .0   1.0   5170
 2- 1-72   1157    9.0   5491   7.56   256  1236  2067  -.10  59.9   682    77   692   258    .0    .8   5107
 5- 2-72   1421   23.3   6781   7.56   256  1262  2067   .12  56.0   715    79   600   265    .0   1.0   5169
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMR  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4      F DS-SUM
 6- 1-72   1660  23.3  6988  7.23   260  1300  2170   .44  50.9   733    86   670   276    .4    1.1   5313
 7-10-72   1523  27.5  7511  7.62   268  1349  2210   .20  51.1   733    82   653   275    .1    1.1   5477
 9- 7-72   1596  25.6  7636  7.61   276  1398  2044  -.08  46.9   708    89   696   283    .1    1.1   5382
 1- 6-73   1867 -99.0  7198  7.47   261  1329  2117   .10  38.0   691    82   676   275    .2   30.0   5319

LW 31 CHARLESTON DITCH      20S 61E 36 347 1
 9- 6-70    167  24.0  2245  8.45   319   103  1190  -.10   3.2   120    20   140   202    .0     .4   2000
 9-11-70    216  28.9  2077  8.09   311    90   940   .93   5.3   116    25   175   173    .0     .3   1677
 9-11-70    217  20.9  2208  7.97   317    75  1006   .83   6.5   123    27   192   163    .0     .3   1730
12-16-70    329 -99.9  2650  8.21   336   109  1271  -.10   6.0   136    36   216   196    .0     .3   2120
 4-23-71    454  21.7  2729  7.70   176   119  1277   .26   5.1   116    35   217   210    .0     .6   2066
 5-14-71    537  25.0  2451  7.90   337   115  1245   .44   5.6   148    32   207   215    .0     .3   2136
 7-26-71    669  27.2  2707  7.65   332   116  1275   .66   6.6   168    32   205   216    .0     .6   2160
 8-31-71    735  27.0  2610  8.15   171    83  1152   .58   7.1   120    31   191   199    .0     .3   1966
12- 2-71    916   6.0  2733  8.03   329   106  1251   .90   8.7   141    33   217   210    .0     .3   2132
 1- 3-72   1058  16.7  2688  8.02   317   110  1255  -.10   6.0   138    27   210   210    .0     .3   2113
 2- 1-72   1175  19.0  2658  8.01   299   117  1212   .26   5.2   137    28   218   195    .0     .3   2059
 6- 1-72   1656  26.6  2672  7.78   322   113  1165   .72   6.1   129    25   202   195    .0     .3   1992
 7-10-72   1566  30.0  2653  7.89   319   116  1195   .60   3.4   132    24   196   189    .1     .3   2008
11- 7-72   1804  24.4  2671  8.99   356   106   710   .56    .1   437    20    75    71    .2-100.0   1689
12- 4-72   1826  21.1  2677  7.56   419   253   820   .08    .2   339    20    96   121    .2-100.0   1864
 1- 5-73   1871 -99.0  2711  7.70   350   119  1203   .20   -.1   133    25   200   205    .2    2.0   2059
 3- 6-73   1997  10.9  2911  7.71   339   125  1297   .36   7.9   147    29   212   217    .2  -99.0   2192
 4- 1-73   2015  17.4  2900  8.12   336   133  1390   .19   8.1   186    32   223   230    .2  -99.0   2337
 5- 2-73   1980  22.8  2937  7.81   321   136  1392   .32   6.9   150    30   210   225    .3  -99.0   2268
 5-10-73   2092  25.6  2840  7.93   333    92  1336   .06   7.2   165    33   201   228    .1     .3   2200
 7- 2-73   2115  27.0  2767  7.79   299   121  1262  -.06   5.5   167    43   208   206    .1  -99.0   2120
 8- 1-73   2177  27.4  2242  8.10   304   111  1088  -.06   5.0   156    30   198   193    .1  -99.0   1929

LW 32 GRAVEL PIT SEEP       21S 63E 32 234 1
 9-10-70    166  22.0  5670  7.62    95  1553  1591  -.10 101.6   516    76   790   275    .0     .5   5026
 9-10-70    165  22.4  7182  7.63    98  1630  2037  -.10 176.9   649    81   796   266    .0     .5   5697
12-15-70    325 -99.9  6955  7.20   172  1263  1966  -.10 160.0   608    96   752   260    .0     .5   5008
 1-19-71    356  20.6  6625  7.32   166  1260  1938  -.10 156.0   510    57   673   297    .1     .6   4970
 4-22-71    459  19.6  7695  7.22   219  1779  1595  -.10 130.5   666    36   795   330    .1     .9   5136
 6-11-71    515  21.0  8600  7.25   213  1982  1668  -.10 100.5   567    36   817   351    .1     .9   5615
 7-23-71    635  22.2  8270  7.17   173  2007  1539  -.10 106.0   666    30   783   320    .1     .8   5553
 8-10-71    707  21.7  7562  7.62   157  1563  1623  -.10  92.0   691    37   949   237    .1    1.0   4700
10- 1-71    787  21.1  7701  7.70   117  1775  1801  -.19 126.0   570    52   868   331    .9     .5   5560
11-10-71    927  22.2  7669  7.31   151  1695  1951  -.10  86.0   696    36   760   296    .9     .9   5602
12- 1-71    996  17.0  7766  7.61   109  1750  1965   .20 157.0   506    63   975   320    .9     .5   5580
 1- 3-72   1013  19.0  7583  7.69   110  1709  1935  -.10  98.0   593    38   832   299    .6     .6   5559
 2- 1-72   1161  17.0  7913  7.93   113  1751  1066  -.10 101.0   522    63   876   317    .6     .5   5697
 4- 2-72   1250  21.7  7856  7.61   136  1811  1922  -.10  56.0   716    30   871   296    .1     .8   5725
 6- 5-72   1340  22.0  8087  7.13   127  1971  1971  -.06  63.0   862    46   777   276    .1     .9   6029
 8- 2-72   1430  22.2  8707  9.40   136  2056  1959  -.06  86.0   950    37   819   263    .1     .8   6238
 6- 1-72   1666  23.9  9501  7.76   142  2390  1773  -.06 122.0  1765    51   762   239    .2    1.0   6609
 7-10-72   1926  22.0  9206  7.96   101  2096  1073  -.06 108.9  1100    36   786   203    .2    1.2   6219
 9- 6-72   1599  23.3  9909  7.62   175  1963  1070   .10 101.0  1155    32   649   196    .1    1.1   6053
 9- 7-72   1665  20.0  7761  7.95   210  1695  1009  -.06 102.0  1065    31   610   170    .1    1.3   5583
10- 1-72   1691  23.3    -0  7.28   212  1695  1671  -.06 116.0  1025    26   990     1    .1    1.3   5221
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LW 33 TRIB TO DUCK CK        21S 62E 22 662 1
 9-11-70   192  18.3  5598  7.36   257  1016  2335   .38   3.1   538    41   648   350    .0   1.8   5078
 9-11-70   193  18.3  6650  7.40   241  1090  2655   .44   3.4   596    73   656   356    .0   1.9   5550
 6-23-71   662  16.6  6896  7.32   272  1002  2870   .20  25.6   650    46   593   368    .0   1.6   5629
 7-26-71   667  23.3  7870  7.38   284  1173  3218   .12  19.6   833    42   654   418    .0   1.7   6441
 9-10-71   714  21.0  7765  7.58   286  1000  3888  -.10  19.1   768    58   613   486    .0   1.6   5996
11-10-71   836  17.2  7040  7.58   229   959  2644   .14  33.0   695    47   536   362    .0   1.6   5661
12- 2-71   915   8.0  6964  7.69   237   991  2765  -.10  30.0   695    51   575   371    .0   1.5   5596
 3- 2-72  1262 -99.0  6863  7.66   231  1012  2886  -.10  32.0   709    55   573   373    .0   1.6   5756
 6- 5-72    -0  19.0  6644  7.20   229   981  2837  2.38  34.0   706    58   583   363    .1   1.7   5671
 5- 6-72  1386  16.5  7097  7.66   258  1019  2967   .10  30.0   742    58   678   386    .1   1.6   5917
 7-10-72  1575  23.1  8216  7.63   266  1126  3609   .10  36.5   844    46   691   476    .1   1.7   6706
 9- 6-72  1629  25.6  9107  7.96   267  1096  3341   .12  36.0   869    43   665   421    .1   1.7   6582
 1- 6-73  1857 -99.0  7160  7.92   231   962  2959   .20  40.0   709    51   629   365    .1   1.7   5828
 1-16-73  1881   9.6  7097  7.96   228   976  2961   .10  37.5   738    56   581   373    .1   1.8   5829

LW 16 LV STP OUTFALL         21S 62E 10 366 1
 3-31-70    26  28.5  1513  7.30   312   180   248 25.20-100.0   145    12    88    53    .0   1.1    889
 5- 6-70    38  22.6  1070  6.98   253   116   255 35.70  27.5   108    13    62    42    .0    .6    789
 6- 6-70    82  28.9  1403  6.80   226   205   193 26.90   8.6   163    13    57    46    .0   1.0    777
 7- 7-70   118  27.8  1126  7.00   196   179   168 41.90   1.1   121    12    57    37    .0   1.1    655
 8- 6-70   146  30.0  1023  7.29   117   116   150 13.90  68.5    83    13    66    42    .0    .7    586
 9-11-70   210  29.6  1669  7.02   180   235   157 17.95  35.6   163    16    72    42    .0    .7    829
 9-11-70   211  29.6  1617  7.29   173   239   190 20.60  67.1   165    11    76    65    .0    .0    905
12-15-70   331 -99.9  1676  7.66   205   199   176 29.70   9.0   183    13    61    38    .0   1.3    869
 1-19-71   360  20.6  1510  7.31   186   216   187 91.60   6.6   157    16    72    60  20.7   1.0    816
 3-10-71   402  22.0  1690  7.26   258   177   222 20.00  16.4   146    16    76    66  17.2   1.1    871
 6-22-71   669  23.3  1921  7.23   301   197   171 31.00   5.0   199    15    65    60  17.2   1.2    889
 6-11-71   926  28.0  1619  7.25   266   232   177 21.10  11.9   166    13    79    63  16.6    .9    882
 7- 7-71   613 -99.0  1606  7.35   265   169   195 28.00   9.6   138    16    70    39  10.6   1.0    795
 7- 7-71   616 -99.9  1675  7.55   260   202   203 26.00  16.5   157    16    77    62  11.1   1.1    866
 9-10-71   721  31.1  1825  7.62   296   235   224 21.60  10.6   178    13    72    62  10.9   1.0    969
10- 1-71   806  25.6  1646  7.19   209   228   227 26.20   6.5   188    16    79    39  21.9   1.0    966
11-10-71   830  23.3  1681  7.26   277   229   226 21.00   2.7   105    12    70    61  29.0   1.0    952
12- 1-71   900  21.0  1792  7.62   270   269   292 16.20   3.3   197    16    85    66  23.0    .8   1020
 1- 3-72  1038   7.2  1776  7.51   260   259   281 15.70   3.6   187    12    89    65  18.6    .6   1020
 2- 1-72  1172  19.0  1865  7.61   291   265   267 16.70   5.2   185    16    83    66  22.0   1.1   1029
 3- 2-72  1258  19.6  1686  7.60   266   286   253 23.00   8.6   196    13    76    66  16.0   1.6    915
 6- 5-72  1366  26.6  1607  7.16   300   256   290 18.00   8.6   182    16    72    65  26.0   1.3    976
 5- 6-72  1388  26.9  1571  7.66   267   218   237 21.00   6.0   165    11    76    66  16.0   1.1    905
 6- 1-72  1452  27.2  1798  7.36   229   276   309 19.30   7.0   208    12    97    60  17.0   1.1   1099
 7-10-72  1533 -99.0  1606  7.23   276   196   258 26.00   6.9   169    13    72    36  17.0   2.1    922
 8- 6-72  1625  30.6  1886  7.76   166   291   303 33.00   9.6   203    13    92    67  17.0   1.5   1081
 9- 6-72  1666  27.2  1922  7.62   268   191   207 18.00   -.0   169    13    87    65  17.0    .7    956
10- 1-72  1696  28.3  1628  7.71   278   213   281 32.00   2.6   191    13    80    37  19.0   1.7   1006
12- 6-72  1827  18.9  1830  7.32   253   236   330 28.00   2.2   196    13    86    67  29.0    .5   1082
 1- 5-73  1863 -99.0  2618  7.35   263   383   926 16.20    .9   277    16   132    70  19.0    .6   1568
 3- 6-73  1993  21.1  2019  7.22   305   256   289 26.00   2.2   207    13    81    61  31.0 -99.0   1093
 6- 1-73  2013  17.8  2021  7.25   299   301   367 16.50   3.6   218    13    90    95  17.0 -99.0   1216
 6- 2-73  1976  25.6  1889  7.22   288   239   299 25.00   2.6   197    10    90    66  27.0 -99.0   1076
 5-10-73  2073  28.3  1566  6.96   197   227   269 19.00   5.2   157    13    73    60  19.0   1.2    987
 7- 2-73  2116  30.6  1848  7.53   338   298   279 15.30    .1   199    20    91    69  22.0 -99.0   1136
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 8- 1-73  2174  31.1   1682  7.45   196   290   297 17.00   7.2   208    16   179    46  17.0 -99.0   1871
 9- 4-73  2235  30.0   1671  7.29   163   270   267 71.00   3.0   187    13    96    39  20.0 -99.0   1089
10- 3-73  2274  26.7   1776  7.47   130   302   274 19.00   6.0   204    16   191    46  20.0   -.0   1050
11- 1-73  2260 -99.0   1299  8.09   118   211   277 23.00   3.7   192    13    76    39  20.0   -.0    903
12- 4-73  2300 -99.0   1455  7.66   121   236   311 20.00   3.9   211    13    80    41  20.0   -.0   1001
 1- 2-74  2311  15.0   1661  7.63   103   269   376 14.30   5.0   202    12   106    49  20.0   -.0   1122

LW 15 BMI NO. 1 (DISC.)     22S 62E 02 144 1
 2-28-70    10 -99.9  14200  3.05   -77  3160   761  -.00  79.7  1375   266   426   373    .0    .6   8444
 3-31-70    19  24.0  24871  9.21    42  7950  2399  -.10 443.0  3600    33  1115   415    .0   1.6  19533
 5- 4-70    39  29.7   8271  3.39   -77  2305   892  -.10 252.9   900    15   320   340    .0    .7   5065
 6- 5-70    74  35.0  29105  6.90    63  7680  1915  -.10 920.9  4050    39  1010   440    .0   1.4  19286

LW 16 OSW GULF RD           21S 63E 14 412 1
 2-28-70     7 -99.9    337  6.33     9    77     2   .01  12.4    51     5     2     0    .0    .1    193

LW 37 OSW HAVERS RD         21S 63E 14 412 2
 2-28-70     8 -99.9    405  6.61     7   222     1   .64  13.7   125    12    71     0    .0    .1    400

LW 38 OSW AEROJECT RD       21S 63E 14 412 3
 2-28-70     9 -99.9    640  6.08     7   209     3   .01  14.5   126    12     4     1    .0    .1    370

LW 19 GRAVEL PIT            22S 62E 02 432 1
 6- 3-70    76  23.6  21902  6.90   110  5700  1300   .32   -.6  3520    52   478   210    .0   4.2  11399
 6- 5-70    77  29.3  26195  7.15   111  6000  2000   .19   -.6  6540    59   532   261    .0   4.6  14251
 9-11-70   196  26.4  17171  7.33    95  5499  1667   .23   -.5  3612    60   500   150    .0   3.0  11530
 9-11-70   199  26.4  17960  7.41    96  5761  1975   .21   -.9  4000    66   405   154    .0   3.2  12591

LW 41 LAS VEGAS WASH 9      21S 63E 30 431 1
 1-19-71   361  13.9   4015  7.94   227   651  1088 19.60  39.2   508    32   298   119    .1   1.3   2860
 3-11-71   376   9.5   3969  7.59   258   646  1071 19.60  39.2   495    32   297   119    .1   1.5   2847
 3-30-71   406  14.6   3970  7.76   249   596  1009 19.00  23.0   460    29   294   109    .1   1.6   2620
 4-10-71   412  14.6   3050  7.81   290   551   993 18.20  24.2   460    29   297   113    .7   1.6   2600
 4-22-71   463  14.6   3391  7.75   265   487   867 20.90  32.3   387    25   222    99    .1   1.3   2262
 6-11-71   518  18.5   3939  7.90   300   550   920 23.20   6.0   427    26   241   105   7.1   1.4   2452
10- 1-71   799  13.9   3056  7.75   293   476   878 18.90  22.0   413    26   210    92   1.4   1.3   2263
11-10-71   825  10.0   4098  7.41   214   622  1079 16.00  30.0   496    33   273   116   2.3   1.0   2776
 1- 3-72  1031   6.9   3130  7.31   215   468   851 19.60  40.0   347    27   217    95   6.0   1.0   2155
 2- 1-72  1164   7.0   3672  7.66   191   455   976 17.00  46.0   376    28   217   107   6.1   1.1   2301
 3- 2-72  1264   9.6   3644  7.08   234   526  1129 19.30  23.0   453    29   245   110    .2   1.2   2557
 4- 5-72  1341  19.0   3378  7.60   246   483  1071 21.00  17.6   410    28   233   110    .5   1.2   2446

LW 42 STAUFFER EFFL 3       22S 62E 12 323 1
 1-19-71   362  21.1   2760  9.29   113   506   554   .36   3.2   513     5    60    74    .0    .3   1729
 4-23-71   456  47.2  68503  8.21  5063 20194  1161  -.10   3.1 20590     8     6     5    .0    .3  52760
 6-11-71   533  37.0  65467  4.30   -77 15646   990  -.10   6.1 10560     5    36    10    .0    .1  27291
 8-10-71   712 -99.9  62796  4.55   -77 19150   799  -.10  13.0 13635     8    51    19    .0   1.7  33676
12- 1-71   908  22.5  41990  4.29   -77 30106  2269  -.10   2.1 22240     9    63    11    .0    .1  56760
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND     PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 1- 3-72  1067  21.9  47200  4.59   -77 16706  1064  -.10   -.1 12100    11    83    25    .0    .2  29990
 2- 2-72  1195  26.0  25437  4.37   -77  8228   556  -.10   1.3  5855     3    24     5    .0   -.1  14672
 3- 2-72  1270 -99.0  38742  7.82  4284 12282   520  -.10   2.6 10119     9    37    18    .1    .2  25094
 5- 4-72  1395  30.0  42737  6.24   628 15670   768  -.04   1.5 11450     6    48    13    .1    .2  28265
 7-10-72  1572  30.0  33657  4.54   -77 11033   961  -.04   1.8  7781     5    48    16    .1    .3  19846
 8- 7-72  1638  29.4  39429  4.98   -77 13350   839  -.04   4.2  9957     7    82    25    .1    .2  24265
 1- 5-73  1860 -99.0    125 12.92  3068 34558  4779-99.99   -.1 37365     8     2    -0    .1   2.2  78223


LW 43 STAUFFER EFFL 6       22S 62E 12 332 1
 1-19-71   364  41.7  43089  8.89 13790 15584   460  -.10   4.0 15500     8     8    12    .0    .3  38349
 4-23-71   455  22.2  19892  1.39   -77  1252  1977  5.50   3.1   125     5    98    31    .0    .4   3489
 6-11-71   534  37.0 278900   .20   -77 28821  1216  -.10  10.4   366     6   102    32    .0   -.1  30553
 8-30-71   715  25.6   3859  3.50   -77   540   831  -.10  12.0   569     5    82    31    .0    .3   2070
 9-23-71   784  11.1   1843  8.84   102   178   535  4.40   4.9   282     8    47    46    .0    .4   1156
11-11-71   814  31.1  13239  1.71   -77  1131  1874  6.20   5.1   643     8    86    36   3.5    .3   3793
12- 1-71   907  26.0 609768  -.00   -77  8228182584  -.10 481.0  8240    14   122    48   1.2   -.1 199711
 2- 2-72  1196  22.0 636711   .06   -77  8367189334  -.10  52.0  2190     7   103    31   1.2   -.1 200085
 3- 2-72  1271  18.9   7654  2.00   -77   700  1396  9.20  10.0   595     5    87    32    .2    .3   2835
 5- 4-72  1396  23.0   5700  1.11   -77  4912  3343  6.60   3.0  1250     4   113    33    .2    .3   9664
 6- 1-72  1466  30.0  61707   .83   -77  3273  8278 68.00   8.0   763     5    94    34    .2    .3  12524
 8- 7-72  1639  33.3 173567   .07   -77  1469 43301  4.00   4.0  2395    10   132    37    .2   -.2  47353
 1- 5-73  1861 -99.0   2359  2.55     0   321   341  -.04   3.4   143     5    81    29    .2    .3    924


LW 44 STAUFFER EFFL 2       22S 62E 12 323 2
 4-23-71   457  23.9  17803 12.37   -77  1009   364  5.04  60.2  2820     6     1     0    .0    .7   4266
 6-11-71   535  35.0 573300  -.00   -77168310   -78  1.80   4.8   334     5    89    29    .0   -.1 168774
 9-30-71   713  32.2   4788  2.78   -77   488   320  8.50   4.6   567     6   103    23    .0    .2   1521
 9-23-71   783  31.0   1323  3.44   -77   202   275  9.80   1.5   115     4    79    28    .0    .3    715
11-11-71   813  42.2 154453   .77   -77 15836    59127.00   2.3    96     4    62    19   1.0    .1  16206
12- 1-71   909  37.0   2767  2.95   -77   374   356132.00   -.1   291     5    78    29   3.7    .3   1269
 1- 3-72  1068  19.1   2011  2.56   -77   310   314  8.60   -.1   101     4    77    28   1.9    .3    855


LW 45 LAS VEGAS WASH 9A     21S 63E 30 431 2
 3-11-71   377  11.0   4230  7.65   248   694  1091 19.00  46.1   526    31   321   130    .0   1.4   2981
 3-30-71   405  13.3   4278  7.76   245   637  1064 17.80  27.3   500    32   275   120    .1   1.4   2795
 3-30-71   411  15.0   4114  7.92   252   624  1064 17.00  29.0   491    32   278   117    .1   1.4   2777
 4-22-71   442  15.0   3506  7.78   245   519   927 20.30  20.0   415    26   232   105    .1   1.3   2386
 6-11-71   517  21.0   4391  7.80   285   679  1105 20.50  15.2   513    28   299   129    .1    .5   2929
10- 1-71   798  15.0   3806  7.79   251   574  1022 17.50  24.0   480    30   243   109   1.2   1.3   2626
11-10-71   822   8.9   3572  6.52   222   506   930 17.70  36.0   420    31   226   102   3.0   1.1   2382
 1- 3-72  1030   6.9   3591  7.12   288   544   959 18.60  44.0   411    29   232   106   2.9   1.1   2450
 2- 1-72  1163   7.0   3742  7.86   200   506  1026 18.30  47.0   385    30   262   125   2.8   1.0   2502
 3- 2-72  1253  10.0   4201  7.84   230   652  1265 17.20  32.0   518    35   296   137    .2   1.1   3067
 4- 5-72  1342  18.9   3163  7.31   250   432   940 21.00  16.0   378    24   231   103    .8   1.3   2270


LW 47 BMI POND SEEP 1       21S 63E 31 224 1
 3-11-71   380  14.5  10750  7.86   236  2425  2707  -.10  71.3  2020    36   720   198    .0   1.5   8295
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND     PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LW 48 BMI POND SEEP 2      21S 63E 31 221 1
 3-11-71   378  14.5  10750  7.49   280  2378  2404  -.10   4.4  1860    37   652   166    .0   2.4   7651
 3-30-71   408  15.0  10889  7.53   277  2355  2409   .14   5.0  1880    50   592   164    .0   2.4   7594
 3-30-71   414  15.0  10889  7.51   273  2342  2419   .18   5.0  1820    49   586   163    .0   2.4   7521
 6-11-71   520 -99.0  11714  7.60   275  2388  2524   .18   6.4  1891    52   570   169    .0   2.5   7738
 7- 7-71   618 -99.9  11520  7.80   283  2392  2482  -.10   9.0  1824    59   616   167    .0   2.6   7691
 7-26-71   641  22.2  11178  7.43   301  2395  2607   .24   9.0  1930    55   598   174    .0   2.5   7911
 8-31-71   726  22.0  11647  7.60   302  2447  2555   .22  10.8  1920    58   610   173    .0   2.5   7925
 9-28-71   791  18.3  10959  7.64   292  2392  2509   .26  10.4  1865    65   596   170    .0   2.6   7754
11-11-71   812  15.0  11206  7.56   288  2454  2414   .22  13.8  1858    61   599   177    .0   2.3   7721
12- 1-71   902  16.0  11792  7.65   293  2505  2421   .40  15.0  1862    52   594   189    .0   2.2   7784
 1- 3-72  1075  11.9  11595  7.66   292  2718  2523   .28  15.0  1970    46   635   196    .0   2.2   8249
 2- 2-72  1190  11.0  11514  7.79   279  2607  2544   .30  21.0  1962    58   645   196    .0   2.2   8172
 3-10-72  1275 -99.0  10707  7.48   286  2524  2588  -.10  18.9  1906    54   571   192    .8   2.1   7997
 5- 4-72  1389  19.5  11463  7.49   288  2493  2551   .16  29.0  1913    55   615   201    .2   2.1   7911
 6- 1-72  1446  21.7  10778  7.73   287  2367  2608   .60  32.0  1830    57   615   201    .3   2.2   7854
 7-10-72  1565  26.1  11483  7.70   301  2387  2703   .60  35.3  1807    58   630   204    .1   2.3   7984
 8- 6-72  1631  27.2  11538  7.64   295  2370  2581   .26  40.0  1865    58   634   196    .2   2.3   7900
10- 1-72  1700  21.1  10919  7.39   318  2443  2556   .24  18.7  1895    60   640   205    .2   2.3   7977
11- 8-72  1822  16.7  11555  7.53   332  2407  2583   .20  12.9  1921    58   637   205    .3   2.5   7990
12- 4-72  1831  15.0  12543  7.55   339  2852  2740   .22  11.7  2167    61   731   222    .3   2.4   8954
 1- 5-73  1850 -99.0  11796  7.35   330  2520  2647   .30  13.6  1908    54   599   195    .3   2.2   8182
 2- 1-73  1918  12.8  10617  7.58   307  2827  2624   .22  15.4  1897    49   581   201    .3 -99.0   8346
 3- 4-73  1986  15.6  12223  7.69   299  2339  2649   .22  16.6  1947    51   569   201    .2 -99.0   7920
 4- 1-73  2006  15.6  11005  7.61   298  2259  2641   .18  19.5  1935    52   567   199    .2 -99.0   7820
 5- 3-73  2041  25.0  10583  7.72   286  2311  2637   .34  13.2  1880    51   574   204    .6 -99.0   7812
 5-11-73  2106  22.8  10562  7.68   295  2329  2684   .24  23.0  1770    54   579   216    .4   2.2   7803
 7- 2-73  2127  28.9  10399  7.84   304  2192  2691   .17  24.3  1755    93   596   217    .2 -99.0   7718
 8- 1-73  2166  24.4   9538  7.94   238  2118  2757  -.04  22.0  1667    65   596   230    .2 -99.0   7572
 9- 5-73  2245  25.0   9350  8.15   303  2225  2707   .30  24.0  1631    59   663   250    .2 -99.0   7709
10- 2-73  2269  22.2  10636  7.80   177  2177  2308   .17  23.0  1671    53   615   232    .2   -.0   7167
11- 1-73  2286 -99.0  10395  7.97   229  2149  2670   .72  24.0  1656    49   607   229    .2   -.0   7498
12- 4-73  2294 -99.0   8961  7.84   216, 2073  2606  -.04  24.0  1619    48   605   234    .2   -.0   7315
 1- 2-74  2317  12.2   8940  8.06   145  2206  2565   .12  17.1  1624   117   586   233    .2   -.0   7420

LW 49 BMI POND SEEP 3      21S 63E 31 222 1
 3-11-71   379  15.0  10530  7.32   242  2437  2141   .10   -.1  1880    36   600   127    .0   3.5   7344
 3-30-71   409  17.2  10780  7.49   269  2359  2189   .24    .2  1890    50   520   131    .0   3.1   7275
 3-30-71   415  16.1  11000  7.51   259  2376  2087   .26    .1  1900    47   510   125    .0   3.3   7176
 5-14-71   539  21.5  11217  7.45   264  2434  2079   .26   -.1  1815    52   507   134    .0   3.3   7154
 7- 7-71   619 -99.9  10983  7.60   226  2408  2074   .26    .1  1764    55   515   138    .0   3.0   7069
 7-26-71   642  23.3  10627  7.33   280  2384  2146   .24   -.1  1945    53   476   142    .0   3.0   7287
 8-31-71   727  21.0  11850  7.55   262  2470  2136   .30   -.1  1931    52   496   135    .0   3.2   7352
 9-28-71   792  18.3  10252  7.56   247  2454  2085   .31   -.1  1951    51   491   176    .0   3.5   7284
11-11-71   811  15.6  11032  7.49   243  2416  1965   .26    .2  1855    56   476   118    .0   3.2   7009
12- 1-71   903  16.0  10527  7.35   235  2486  1999   .30    .2  1890    58   454   127    .0   3.0   7133
 1- 4-72  1076  14.0  10589  7.56   240  2524  2018   .24   1.1  1910    43   465   127    .0   3.0   7210
 2- 2-72  1191  13.0  10684  7.45   246  2452  2043   .10   1.6  1936    57   469   134    .0   3.2   7216
 3-10-72  1276 -99.0  10265  7.46   258  2485  2136   .25   3.7  1945    56   472   124    .5   3.4   7349
 5- 4-72  1390  19.0  10213  7.56   265  2427  2105   .32   2.8  1915    54   488   129    .2   3.3   7247
 6- 1-72  1447  21.1  10216  7.27   261  2406  2167   .32   -.1  1910    54   477   129    .2   3.5   7275
 7-10-72  1566  21.7  10938  7.46   269  2406  2219   .36   -.1  1861    54   495   134    .1   3.4   7295
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4      F  DS-SUM
 9- 6-72  1632  24.4  10645  7.64   263  2404  2221   .38    .1  1985    53   480   134    .2    3.3    7411
10- 1-72  1698  21.1  10314  7.25   266  2439  2145   .26   -.1  2010    56   482   134    .3    3.5    7401
11- 8-72  1823  16.7  10709  7.27   268  2447  2164   .26    .2  1899    53   475   139    .4    3.6    7313
 1- 4-73  1851 -99.0  10544  7.29   270  2341  2208   .30   -.1  1904    50   483   136    .2    3.7    7259
 2- 1-73  1918 -99.0   9971  7.32   271  2236  2214   .22    .4  1857    48   454   135    .3  -99.0    7078
 3- 4-73  1987  16.1  10358  7.61   270  2271  2167   .28   -.1  1930    50   446   128    .2  -99.0    7125
 4- 1-73  2005  16.7  10100  7.46   276  2211  2186   .28   -.1  1935    51   441   130    .2  -99.0    7090
 5- 3-73  2037  21.7   9954  7.46   285  2236  2175   .44    .2  1813    49   436   141    .6  -99.0    6991
 5-31-73  2105  26.1   9814  7.32   325  2191  2380  2.60   2.1  1575    55   538   232   3.2    1.8    7141
 7- 2-73  2128  28.3  10589  7.25   408  2307  2521  2.60    .7  1715    99   587   247    .7  -99.0    7680
 8- 1-73  2167  23.3   9169  8.15   313  2167  2110  1.00   -.1  1700    63   455   150    .7  -99.0    6801
 9- 5-73  2246  22.8   8729  8.19   303  2206  2094   .30   -.1  1695    57   462   169    .7  -99.0    6833
10- 2-73  2268  22.2   9956  8.13   229  2483  2101   .62   -.5  1707    48   444   150    .7    -.0    7047
11- 1-73  2285 -99.0   9979  8.34   277  2111  2102   .73    .2  1687    45   443   143    .7    -.0    6669
12- 4-73  2295 -99.0   9771  7.95   261  2149  2077  1.07    .1  1666    44   444   153    .7    -.0    6663
 1- 2-74  2316  11.6   6185  8.22   130  2138  2133  -.07   -.1  1692    45   430   147    .7    -.0    6649

LW 50 E. WASH AVE DITCH    20S 62E 30 243 1
 4-23-71   464  27.2   1518  7.49   208    69   538  7.00    .3   104    31   122    84    .0     .5    1078
 6-14-71   538  36.0    998  9.60   -77    96   265   .12    .2    64    13    67    31    .0     .4     537
 8-31-71   736  26.0   1493  7.77   158   127   442  1.96    .2   137    15   126    38    .0     .5     966
 9-27-71   789  26.0   1993  7.75   149   144   775   .99    .4   173    44   154    90    .0     .5    1454
11-11-71   808  13.3   1433  8.95   317    71   418  2.30    .3    73    13   117    88    .0     .4     938
12- 2-71   917  10.0   1670  7.98   382    92   464  1.70    .3   103    20   120    97    .0     .4    1086
 1- 3-72  1057  10.0   1416  8.30   214    77   409   .96    .2    91    10   104    74    .0     .4     872
 4- 6-72  1359  27.8   1894  8.53   282   186   616  2.50    .7   178    26   160    65    .0     .6    1333
 6- 1-72  1455  35.0   1450  7.41   252   109   466  2.00   7.4   112    16   149    53    .0     .5    1039
 7-10-72  1505  33.3   1673  7.16    98   196   469   .50    .4   158    25   115    41    .2     .8    1050
 9- 6-72  1645  23.9    524  7.40   200    15   117  2.10   3.6    14     6    85    19    .5     .3     362
11- 7-72  1793 -99.9   2032  7.38   261   193   582  4.90    .5   199    29   147    67    .5     .5    1352
12- 4-72  1825  10.0   1768  7.37   222   168   474  8.10    .4   169    16   133    50   2.3     .6    1131
 1- 5-73  1867 -99.0   4656  7.90   273   412  2192  -.04   2.3   318    23   386   321    .2     .7    3772

LW 51 WINTRWD GC STREAM    21S 62E 10 233 1
 4-23-71   463  27.2   4222  7.86   194   380  2008   .46    .1   288    21   384   305    .0     .6    3483
12- 2-71   916   5.0   4029  7.99   259   372  1929  -.10    .5   267    19   380   292    .0     .5    3388
 1- 3-72  1040   8.0   4002  7.85   252   350  1809  -.10   3.1   254    18   348   271    .0     .5    3177
 2- 1-72  1173   5.0   3650  8.14   239   307  1645  -.10   4.0   217    18   331   247    .0     .6    2887
 3- 2-72    -0 -99.0   3832  8.03   213   347  1858  -.10   1.5   235    19   337   272    .0     .6    3174
 4- 5-72  1348  23.3   4156  7.38   164   371  1904   .38   -.1   265    20   347   283    .0     .5    3271
 5- 4-72  1419  27.8   4168  7.97   123   431  1951   .22   4.7   304    22   331   287    .0     .6    3392
 6- 1-72  1453  31.1   4168  7.59   304   365  2040   .90    .4   276    26   424   286    .4     .6    3569
11- 6-72  1793  13.3   4457  7.98    -0   426  2074  -.04    .1   302    21   357   314    .2     .6    3495
 1-31-73  1983  11.1   4046  8.25   187   390  2014  -.04   1.8   283    22   378   299    .3  -99.0    3480
 3- 4-73  1995  18.9   4558  8.01   154   386  1950  -.04   -.1   273    21   345   295    .2    -.0    3346
 4- 1-73  2011  14.4   4093  7.87   236   351  1908  -.04    .7   264    19   372   279    .2    -.0    3310
 5- 3-73  1978  30.0   4872  7.98   144   375  1860  -.04    .2   245    17   333   265    .1  -99.0    3166
 3- 2-74  2325  22.2   3958  7.96   173   345  1840   .04    .7   261    18   334   254    .1    -.0    3138
 4- 4-74  2331  10.0   3958  7.96   268   326  1776   .06    .7   262    17   336   252    .1    -.0    3102
 5- 8-74  2339  23.9   3700  8.45   229   345  1627  1.18    .2   286    16   316   233    .1    -.0    2937
 6- 5-74  2355  32.2   2911  7.62   184   434   964 12.00  12.2   412    37   180    98    .1    -.0    2239
 8- 2-74  2366  35.6   3759  8.29   195   348  1640   .38   -.5   265    21   308   233    .1    -.0    2903
10- 3-74  2378  26.7   2224  7.55   141    97  1070  -.02   7.9   116    35   302    71    .1    -.0    1768
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
11- 6-74  2384  11.1   3862  7.99   283   307  1548   .02   4.0   256    19   305   236    .1   -.0    2814
12- 4-74  2390  10.6   2582  7.26   212   214  1079  -.03   8.0   167    22   229   152    .1   -.0    1975
 2- 6-75  2402  11.1   3698  8.24   224   298  1669   .04   3.5   257    19   304   223    .1   -.0    2804
 3- 7-75  2408  20.0   3523  7.84   231   285  1599   .18    .1   273    20   268   223    .1   -.0    2782
 4- 3-75  2414  19.4   3558  7.51   230   303  1669   .27   3.1   231    18   423   216    .1   -.0    2977
 6- 3-75  2421  24.4   3561  6.70   204   303  1436  1.78   -.1   256    18   271   206    .1   -.0    2592
 7- 1-75  2427  26.7   3917  6.20   176   350  1675   .43   -.5   311    21   294   225    .1   -.0    2963


LW 52 LVBM USED WATER       21S 62E 35 413 1
 5-17-71   470 -99.0  10289  7.51   129  2318  2142  -.10   1.0  1330    69   602   229    .0   1.2    6756


LW 54 LVBM NEW POND         21S 62E 34 443 1
 6-11-71   529  26.0   3026  8.00   169   503   660   .14   -.1   279    24   149   133    .0   1.3    1828
12- 2-71   911   6.0   2520  8.02   150   426   600  -.10   1.0   245    18   139   114    .0   1.0    1618
 1- 4-72  1051  15.6   2576  8.04   148   442   588  -.10   2.2   240    17   140   113    .0   1.0    1616
 2- 1-72  1183   6.0   2502  8.01   154   418   568  -.10   2.9   233    17   129   111    .0   1.0    1556
 5- 3-72  1408  24.4   2918  8.13   157   517   708  -.04   -.1   303    25   144   130    .0   1.3    1897


LW 55 STAUFF CUT FLUME      22S 62E 12 324 1
 6-11-71   532  30.0  18936 12.55   -77  2393   798   .24   7.2  2932     7     6    -0    .0    .3    6143
 7-26-71   638  23.9   4311  8.74   174   961   512   .24   3.7   849    49    52    28    .0    .3    2541
 8-30-71   711  26.7  12621  1.85   -77   849  3228   .58   6.6  1312    11   205    61    .0    .3    5673
 9-23-71   785  29.0   9154  3.90   -77  1235  3280   .39   8.3  2003     8   280    88    .0    .4    6896
11-11-71   815  30.0   9428  2.27   -77  1664  1114  3.00  39.0  1307     7    66    23   2.3    .2    4225
12- 1-71   906  29.0  20394  7.28   255  6663   846   .20   1.2  4430     9   202    75    .9    .4   12353
 1- 3-72  1066  22.0   5767 11.25   -77  1365   434  -.10  16.0  1220     6    33     3   2.6    .2    3079
 2- 2-72  1193  23.0   8407 10.75    49  2533   362  -.10   4.3  1823     6    53    25   2.6    .3    4834
 3- 2-72    -0 -99.0   8843  2.28   -77   702  2732  2.10  12.9  1099    12   158    52    .3    .5    4770
 4- 6-72  1352  24.4  60911  1.36   -77 20960  2127 17.50  10.7 14365    14   178    35    .3    .3   37658
 5- 4-72  1391  29.0  18153  2.31   -77  4774  2254  1.40   4.6  3670     8   155    50    .2   1.0   10919
 6- 1-72  1465  28.3  20842  1.32   -77   947  3509 28.00  11.2   402     5   170    37    .2    .3    5110
 7-10-72  1571  26.1   3069  2.90   -77   468   629  -.04   9.5   302     6   102    40    .2    .4    1557
 8- 7-72  1640  28.9   5187  3.67   -77  1400   431   .30   3.5   944     4    94    31    .2    .3    2898
 9- 7-72  1663  30.0  14501 12.51     0  2237   508   .08   5.2  2595     6    19     1    .2    .3    5372
10- 1-72  1679  28.3   3872 11.80     0   588   320  -.04   4.7   699     5    17     6    .2    .3    1641
 1- 5-73  1862 -99.0  12416 13.35     0 15815  2267  -.04  27.5 22180    17    70    -1    .2-100.0   40297


LW 57 CORN CREEK SPRING     17S 59E 34 112 1
 6-14-71   543  27.2    524  7.65   289    11    22  -.10   3.8     7     2    91    33    .0    .2     271


LW 58 BONNIE SPRINGS        22S 58E 02 332 1
 6-15-71   544  19.2    782  7.50   356    17    92  -.10    .5    11     2    91    41    .0    .2     430


LW 59 FLAM RES COMP GW      21S 62E 19 111 3
 1- 5-72  1087 -99.0    913  7.80   224    22   278  -.10   3.8    20     3   105    44    .0    .3     587
 2- 2-72  1185  17.0    923  7.76   226    24   282  -.10   3.8    23     3    97    49    .0    .4     594
 7-10-72  1578  19.4   1059  7.75   225    39   342  -.04   2.4    26     3   114    54    .0    .4     691
10- 1-72  1687  20.6   1577  7.92   204   135   532   .28   3.7   113     6   146    64    .2    .5    1101
11- 7-72  1798 [illegible]  1568  7.76   160   151   497  3.70   1.9   141    10   141    39   1.3    .6    1065
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POINT IDENTIFIER AND LOCATION
MO DA YR   NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 5- 2-73   2030  25.6   1000  6.85    91   375   590 14.70   2.0   140    34   163    39  14.0 -99.0   1417
 5-30-73   2099  30.6   1664  7.23   140   151   538   .98    .6   166    14   145    30    .3    .6   1120
 7- 2-73   2113  31.1   1768  7.13   140   158   564   .72    .4   193    32   150    36    .5 -99.0   1289
 9- 1-73   2182  33.3   1592  7.88   151   138   504   .88    .2   189     9   150    32    .5 -99.0   1097


LW 60 FLAM WASH 3           21S 61E 12 413 1
 7-26-71    651  23.3   4962  7.59   332   383  2550  -.10   -.1   340    20   429   370    .0    .6   4264
 8-31-71    733  24.0   4679  7.65   315   331  2222  -.10    .3   285    19   437   333    .0    .6   3783
 9-27-71    786  19.0   4892  7.77   327   399  2542  -.10    .1   351    23   466   388    .0    .7   4322
11-11-71    807  15.6   5280  7.74   324   395  2389  -.10    .5   344    23   445   375    .0    .6   4132
12- 2-71    922  14.0   4595  7.68   332   533  2307  -.10    .8   312    25   455   390    .0    .6   4106
 1- 4-72   1072   8.1   4299  7.78   321   298  2115  -.10   2.4   265    21   434   300    .0    .6   3594
 2- 1-72   1177   8.0   3703  8.19   311   226  1904  -.10   3.6   223    23   391   260    .0    .7   3105
 3- 3-72   1272 -99.0   4085  8.02   304   278  2109  -.10   1.8   256    20   385   293    .0    .7   3493
 4- 5-72   1334  18.[illegible]   4504  7.37   327   348  2418  -.04    .5   313    20   426   349    .0    .7   4036
 5- 4-72   1385  21.0   4387  7.84   347   330  2319  -.04   2.4   302    20   434   332    .0    .7   3911
 6- 1-72   1459  23.9   2912  6.87   303   175  1396  -.04    .0   156    24   311   184    .0    .6   2396
 7-10-72   1580  25.0   4712  7.64   323   326  2410  -.04    .8   299    19   439   332    .1    .7   3985
 8- 7-72   1635  24.4   4826  7.63   332   327  2315  -.04   -.1   295    19   434   332    .1    .7   3886
 9- 5-72   1641  20.6   4330  7.54   296   328  2148   .14   1.0   285    26   378   318    .1    .6   3622
10- 1-72   1686  20.6   4510  7.35   329   341  2352  -.04    .4   307    20   427   339    .2    .7   3949
11- 7-72   1808  16.1   4539  7.51   335   312  2274  -.04    .8   292    21   408   319    .2    .7   3792
12- 4-72   1841  13.3 -99999  7.64   336   284  2186  -.04   1.7   290    24   406   307    .1    .8   3665
 1- 5-73   1869 -99.0   4325  7.82   341   271  2203  -.04   2.2   280    24   396   306    .2    .6   3651
 1-31-73   1905  11.1   3650  7.94   325   221  1954  -.04   3.4   223    26   379   261    .2 -99.0   3227
 3- 5-73   2001  13.3   4350  7.92   335   252  2066  -.04   1.7   255    23   407   284    .1 -99.0   3454
 4- 1-73   2016  17.0   4042  7.72   322   241  2049  -.04   2.6   250    23   402   277    .1 -99.0   3407
 5- 2-73   1981  24.4   3836  7.37   281   243  1993   .20    .4   236    15   378   263    .6 -99.0   3268
 5-30-73   2100  30.6   4434  7.72   330   318  2353  -.04    .4   294    20   424   325    .2    .5   3890
 7- 2-73   2113  22.2   5000  7.87   330   335  2550  -.04    .7   395    42   430   355    .1 -99.0   4242
 9- 1-73   2178  25.6   4765  7.70   262   326  2548  -.04    .3   346    22   442   349    .1 -99.0   4162


LW 61 LVSTP INFL            21S 62E 10 342 1
 1- 3-72   1039  21.9   1878  7.10   320   268   235 41.00   -.1   286    12    80    39  32.7   1.5   1072
 4- 5-72   1347  25.6   1180  6.97   440    91    74 33.00    .2   120    13    61    34  21.0   1.4    666


LW 62 CLARK CO STP INFL     21S 62E 22 222 1
 1- 3-72   1055  21.9   1661  7.03   338   125   353 36.00   -.1   177    14    96    44  22.8    .7   1035
 4- 5-72     -0  23.9   1474  6.91   448   134   216  2.00    .2   155    18    85    40  20.0   1.1    900


LW 63 LVW 4 NORTH           21S 63E 29 324 2
 7- 7-71    622 -99.9   5360  7.95   296   862  1432 13.50   3.3   699    34   390   137    .7   1.5   3719
 7- 7-71    625 -99.9   5643  8.00   298   940  1489 14.10   2.9   678    34   404   143    .6   1.5   3850
 7- 7-71    628 -99.9   6043  8.00   298   998  1592 13.80   2.1   735    35   427   158    .6   1.6   4098
11-10-71    823   8.9   3933  7.77   226   565   995 17.80  43.0   450    31   248   108   1.0   1.2   2571
12- 1-71    895  10.8   3118  7.43   211   457   862 20.80  40.0   362    27   215    99   1.4   1.0   2109
 1- 3-72   1032   6.9   3252  7.84   197   462   899 19.60  46.0   378    27   210    98   1.1   1.1   2238
 2- 1-72   1165   2.0   3383  7.57   195   457   970 18.70  52.0   392    33   227   109   1.4   1.0   2357
 3- 2-72   1256   9.4   3843  7.74   243   501  1163 19.30  22.0   454    34   263   123    .3   1.2   2701
 5- 4-72   1376  15.5   3668  7.94   269   517  1096 21.00   8.9   462    24   255   111    .3   1.3   2629
 7-10-72   1530  23.5   3762  7.81   269   485  1050 21.00  15.1   442    25   245   105    .1   1.4   2522
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LW 54 DUCK CK AT US 93      21S 62E 27 434 1
 7-10-72  1573  31.1   3732  6.78   118   623   933  1.70   2.8   467    33   219    79  10.0    .8   2428

LW 65 LVN ABOVE LW030       21S 63E 28 131 3
11-11-71   816  13.3   5678  8.00   211   997  1380 11.00  58.0   567    63   434   187    .0   1.0   3802
12- 1-71   925  15.0   5061  7.45   223   895  1386 10.50  66.0   496    62   423   182   2.1   1.0   3634
 1- 3-72  1008   9.0   5034  7.60   212   883  1394 10.30  58.0   534    53   402   176    .8   1.0   3616
 2- 1-72  1158   5.0   5108  7.84   205   851  1378 12.60  63.0   512    56   387   177    .2   1.0   3538
 3- 2-72  1245  13.9   5896  7.66   241  1110  1732  6.00  61.0   612    74   486   220    .2   1.0   4421
 4- 5-72  1337  19.0   5119  7.40   239   936  1506 10.50  47.0   551    59   416   186    .2   1.1   3831
 5- 4-72  1366  17.0   5732  7.74   258  1052  1642  8.40  49.0   595    67   504   207    .2   1.1   4249
 6- 1-72  1439  21.7   5425  7.23   255   999  1529 10.70  42.0   588    66   441   197    .0   1.1   4000
 7-10-72  1524  21.0   6657  7.57   249  1279  1809  3.00  50.0   663    81   591   244    .1   -.0   4921
 8- 6-72  1597  25.0   7183  7.56   254  1299  1884  1.70  53.0   653    84   594   254    .1   1.0   4948
10- 1-72  1685  20.0   6805  7.32   245  1365  1856   .65  96.0   678    94   611   269    .2   1.0   5051
10- 5-72  1788  20.0    494  7.10   267     7    26  -.00   1.7    16     3    29    34    .2    .7    248

LW 66 HEND STP INFL         21S 62E 36 344 2
 1- 3-72  1052  19.1   2919  7.01   254   458   607 35.00   4.6   360    18   173    65  19.1    .7   1865
 4- 6-72  1356  22.2   2733  6.93   371   419   558 31.00   3.9   334    19   167    67  29.0    .9   1811

LW 67 BMI STP INFL          220 63E 07 111 1
 1- 3-72  1063  20.0   1500  7.83   186   135   328 53.00    .6   157    11    88    29  14.4    .2    908
 4- 6-72  1354  21.7   1495  7.31   345   136   289 29.00    .3   168    12    84    32  28.0    .7    940

LW 68 BC STP INFL           23S 64E 09 431 1
 1- 6-72  1042  17.8   1540  7.08   250   132   305 51.00    .5   175    15    75    28  31.2    .4    936
 4- 6-72  1363  22.2   1515  6.95   248   163   298 45.00    .4   183    14    85    31  20.0    .3    963

LW 69 BC STP EFFL           23S 64E 09 431 2
 1- 6-72  1043   5.0   1762  7.63   271   214   367 34.00    .3   224    15   104    35  20.5    .3   1148
 4- 6-72  1364  20.6   1894  7.55   277   243   412 22.00    .3   258    19    96    39  13.0    .2   1231

LW 70 FLAM WASH AT LAMB     21S 62E 05 322 1
 1- 4-72  1073   6.0   3285  7.89   265   326  1735  -.10   3.6   245    18   355   248    .0    .4   3071
 2- 2-72  1186  10.0   4170  8.27   239   369  1912  -.19   2.1   262    19   368   295    .0    .6   3345
 3- 2-72    -0 -99.0   3958  8.09   219   359  1922  -.10    .9   259    17   341   290    .0    .6   3298
 4- 6-72  1362  25.6   4279  8.00   188   408  2088   .08    .3   288    18   372   309    .0    .5   3561
 5- 4-72  1384  31.0   4168  8.20   188   417  1989  -.04   -.1   282    16   362   296    .0    .6   3451
 6- 1-72  1456  33.3   4291  7.69   298   422  2073   .10    .1   304    19   409   313    .0    .6   3687
 7-10-72  1583  31.7   4108  7.78   129   419  1898  -.04    .2   291    18   326   273    .1 -99.0   3289
11- 7-72  1809  14.4   4663  8.15   229   444  2155  -.04    .9   319    20   383   326   3.7    .6   3765
12- 6-72  1826  13.3   4678  8.10   278   414  2131  -.04   1.8   309    23   396   313    .1    .6   3725
 1- 5-73  1868 -99.0   4491  8.12   283   399  2101  -.04   4.6   299    21   382   314    .1    .5   3661
 1-31-73  1904  12.2   4234  8.40   136   416  2157  -.04   2.5   303    23   371   316    .3 -99.0   3656
 3- 4-73  1996  15.6   4536  7.98   167   402  2100  -.04   1.2   294    20   369   307    .1 -99.0   3575
 4- 1-73  2016  13.9   4295  8.12   186   430  2085  -.04    .6   284    19   379   299    .1 -99.0   3588
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP   COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 5- 2-73  1979  25.6   4180  7.87   217   398  2050  -.04    .4   277    15   376   295    .6 -99.0    3519
 5-30-73  2091  25.0   4374  7.78   267   432  2039  -.04   -.1   292    19   376   310    .2    .6    3600
 7- 3-73  2114  28.3   4296  7.89   289   425  1872  -.04    .2   300    27   346   274    .1 -99.0    3347
 8- 1-73  2176  33.3   4744  8.08   236   460  1870   .10    .2   321    23   384   295    .1 -99.0    3469


LW 71 UPPER POND SEEP      21S 63E 31 331 3
 1- 4-72  1071   6.0   9413  7.65    94  1964  2751  -.10 172.0  1170    38   705   387    .0    .4    7213
 2- 2-72  1189  10.0   9070  8.01    85  1800  2583  -.10 179.0  1072    39   684   371    .0    .5    6770
 3- 2-72  1266 -99.0   8928  7.95    88  1830  2787  -.10 165.0  1080    34   686   396    .0    .6    7912
 7-10-72  1570  28.9  14578  7.67   144  3264  4863  -.04 194.0  1955   100   917   629    .0   -.0   11192


LW 72 FLAM WSH AT EMRSN    21S 61E 13 123 1
 1- 4-72  1041   8.1   3473  8.00   370   174  1774  -.10   2.2   190    29   380   238    .0    .8    2969
 2- 1-72  1178   8.0   3440  7.94   354   162  1684  -.10   5.0   176    30   359   236    .0    .7    2827
 7-11-72  1587  27.2   4966  7.40   363   264  2673   .40   2.6   366    36   474   325    .0   -.0    4320
11- 7-72  1794 -99.9   3580  7.77   380   170  1750  -.04   2.3   193    32   380   236    .1    .8    2951
12- 4-72  1842  11.1 -99999  7.72   380   176  1789  -.04   3.8   202    33   367   237    .1    .9    2995
 1- 5-73  1870 -99.0   3601  7.70   381   172  1791   .08   6.0   196    33   366   247    .3    .8    2999
 3- 5-73  2000  11.1   3625  7.92   368   172  1771  -.04   3.3   185    28   374   236    .1   -.0    2950
 4- 1-73  2017  13.3   3406  7.85   355   159  1692  -.04   3.3   172    25   36[illegible]   225    .1   -.0    2820
 5- 2-73  1982  17.8   2538  7.76   265   120  1402  -.04    .6   129    15   31[illegible]   167    .2 -99.0    2281
 5-30-73  2101  22.2   3208  7.85   361   156  1645  -.04    .5   166    28   338   221    .2    .8    2733


LW 73 NE COR LOW POND      21S 63E 31 222 2
 1- 4-72  1077   6.0  11245  7.75   334  2568  2648  -.10  13.0  1994    61   575   239    .0   1.6    8266
 2- 2-72  1192   8.0  11572  7.84   389  2568  2676  -.10  21.0  2018    57   561   258    .0   1.6    8313
 3-10-72  1278 -99.0  11159  7.94   294  2670  2724  -.10  17.7  2040    76   538   249    .0 163.0    8614
 6- 1-72  1448  28.9  13792  7.63   197  3224  3618   .08  26.0  2430    88   672   356    .2   2.0   10514
 7-10-72  1567  23.9  16071  7.61   272  3579  3887   .10   8.5  2706   108   732   388    .4   -.0   11527
 1- 4-73  1852 -99.0   9633  7.77   347  1877  2457   .08   4.0  1597    58   339   216    .2   1.8    6721


LW 74 FLAM RES DRAIN 1     21S 62E 19 111 4
 1- 6-72  1078  16.1   1842  8.01   253   157   645  -.10   8.7    95     5   187    99    .0    .4    1322
 2- 1-72  1179  16.0   1877  7.99   123   156   631  -.10   7.7    84     4   174   100    .0    .4    1218
 7-11-72  1588  34.4   1891  7.41   177   155   645  1.08   3.4   169    13   182    38    .0 -99.0    1293
11- 7-72  1795  18.3   1135  7.37   225    46   375  -.04   2.3    30     3   127    59    .0    .4     753
 1- 5-73  1872 -99.0   1193  7.52   223    52   405  -.04   3.4    36     3   135    62    .2    .4     806
 3- 5-73  1998  17.8   1347  7.79   222    70   433  -.04    .5    39     3   150    66    .2 -99.0     872
 4- 1-73  2019  17.8   1465  7.66   217    78   451  -.04   4.0    41     3   152    68    .2 -99.0     904
 5- 2-73  1967  18.9   1400  7.75   211    89   465  -.04   4.2    40    -1   149    72   -.1 -99.0     923
 5-30-73  2097  23.3   1445  7.81   221    99   487  -.04   4.9    42     3   152    80   -.1    .4     977
 7- 2-73  2120  22.8   1498  7.93   215   112   511  -.04   4.1    44    21   160    77    .1 -99.0    1035
 8- 1-73  2179  18.9   1482  8.00   176   123   549  -.04   4.9    43     4   166    80    .1 -99.0    1057


LW 75 FLAM RES DRAIN 2     21S 62E 19 111 5
 6-14-71   545  21.7   1083  7.85   227    46   319  -.10   3.0    38     4   114    48    .0    .4     684
 8-31-71   732  20.6    876  7.48   226    26   257  -.10   2.7    24     3   102    45    .0    .4     571
 7-10-72  1579  20.0   1353  7.99   179   116   484  -.04   3.4   110     5   107    46    .0 -99.0     879
11- 7-72  1796  17.8   2249  7.46   232   217   749  -.04  10.4   137     5   199   114    .0    .4    1545
 1- 5-73  1873 -99.0   2401  7.76   247   236   829  -.04  15.4   137     5   204   134    .1    .5    1682
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM
 1- 5-73  1999  17.8  2436  7.74   240   225   787  -.04  10.0   126     4   200   125    .1 -99.0  1595
 4- 1-73  2019  16.7  2213  7.79   233   213   761  -.04  13.1   128     5   199   119    .1 -99.0  1552
 5- 2-73  2038  18.9  1544  7.69   209   128   532  -.04   6.0    75    -1   151    78    .1 -99.0  1072
 5-10-73  2098  20.0  1584  7.85   214   134   532  -.04   5.8    81     5   150    81    .2    .4  1094
 7- 2-73  2121  22.2  1638  7.98   208   138   534  -.04   4.8    97    23   156    78    .2 -99.0  1132
 8- 1-73  2180 -99.0  1682  8.00   184   153   561  -.04   6.2   131     6   170    80    .2 -99.0  1197

LW 76 CCSTP OUTFL FLUME     21S 62E 22 242 1
 5- 2-73  1974  24.4  2400  7.11   284   310   563 19.50   2.9   268    13   135    64  36.0 -99.0  1551
 5-10-73  2096  26.7  2760  6.63   133   454   686 18.50   2.9   323    16   146    76  20.0    .5  1737
 7- 2-73  2118  28.9  2817  7.15   303   408   683 18.70   1.6   326    33   151    73  30.0 -99.0  1794
 8- 1-73  2172  28.9  2192  7.80   143   380   588 17.00   4.3   321    22   157    57  22.0 -99.0  1639

LW 79 LV CK AT FNSY PRK     20S 61E 26 322 1
 9- 6-72  1650  23.3   630  7.17   245    33   112  1.30    .8    25     9    95    28    .0    .3   416

LW 80 LV CRK AT MAIN ST     20S 61E 27 343 1
 9- 6-72  1651  22.8   497  7.83   171    20    92  1.60    .8    19     9    58    13    .0    .2   299

LW 81 LV CRK AT RANCHO      20S 61E 29 443 1
 9- 6-72  1652  22.8   319319.00   128    12    48  2.20    .3     7     4    47     9    .0    .2   183

LW 82 LV CRK AT BEDFORD     20S 61E 31 214 1
 9- 6-72  1653  23.9  2470  6.98  1090     7    30  1.50   3.4     7     4    34     6    .5    .1   630

LW 83 LVW BELOW LWOGS       21S 63E 28 131 3
12- 4-72  1837  15.6  7187  7.43   257  1382  1946   .48  52.0   677    90   630   273    .0   1.1  5186

LW 84 SAHARA-NEV. C.C.      21S 61E 14 142
 1-31-73  1908  12.2  2716  7.52   355   135  1200  -.04   3.3   142    18   290   172    .0    .8  2215

LW 85 LEROY APTS.           20S 61E 26 331 1
 1-15-73  1874  14.4  2433  7.84   395    88  1080  -.04   8.9   108    18   165   218    .0    .3  1871

LW 86 HPLND PKWY HARRS      20S 61E 26 331 2
 1-15-73  1875  17.2  1878  7.72   316    66   748  -.04   9.1    82     9   137   146    .0    .3  1353

LW 87 DALLARD NO ESTRN      21S 61E 02 111
 1-15-73  1876  19.4  4119  7.67   365   213  2076   .20  13.3   276    88   257   317    .0    .5  3421

LW 88 MONT WARDS            21S 61E 01 211
 1-15-73  1877  23.3  4583  7.61   321   312  2184  -.04  12.3   397    41   258   320    .0    .3  3683
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POINT IDENTIFIER AND LOCATION
MO DA YR  NUMB  TEMP  COND    PH  HCO3    CL   SO4   PO4   NO3    NA     K    CA    MG   NH4     F  DS-SUM

LW 89 CORTZ  PRKING LT     20S 61E 34 131
 1-16-73  1879  20.6   1927  7.51   356   105   557   .20   -.1   174    15   120    78    .0    .4   1220

LW 90 CONV CNTR            21S 61E 10 331
 1-19-73  1883  20.0   3099  7.61   279    98  1551  -.04  29.3   153    11   291   214    .0    .3   2488

LW 91 DUNES HD             21S 61E 20 114
 1-19-73  1884  27.8   2151  7.58   154    74  1083  -.04   3.4    42    10   356    85    .0    .6   1738

LW 92 SAHARA HD            20S 61E 09 111
 1-21-73  1885  17.8   4644  7.49    71   267  2461  -.04   -.1   449   109   507    99    .0    .4   3929

LW 94 SEARS                21S 61E 14 223
 1-24-73  1888  20.0   3039  7.62   242   171  1514  -.04  10.6   178    23   268   214    .0    .6   2495

LW 96 BONANZA HD UPRR      20S 61E 27 341
 1-28-73  1890  12.2   1606  7.87   545    83   350-99.00    .3    57    10   139   102    .0    .4   1010
 1-28-73  1891  11.7   1545  7.95   360   111   416  -.04  26.0    88    15   126    93    .0    .4   1044

LW 98 CAS CTR HD OGD 30    20S 61E 34 211
 1-16-73  1878  17.8    665  8.14   221    38   116-99.00   1.5    21    10    40    51    .0    .3    387

LW 99 DEL AMO HD SAND 9    20S 62E 31 341
 1-18-73  1882  17.2   8722  7.88   194   534  5633-99.00  12.7   924   826   403   758    .0    .4   8985

LW100 CEN TEL BLDG         20S 61E 34 133
 1-19-73  1886 -99.0   1576  7.92   416    85   477-99.00    .2    87    24    84   116    .0    .3   1078
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Appendix 4. Chemical Analyses Used to Determine Historical Changes in Ground-Water Quality

Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Concentration of principal ions, mg/l											Dissolved solids mg/l			Specific cond (micromhos/cm)	Hardness (as $CaCO_3$)
						Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation		
19/60- 9cdal	MJ	612	10-23-44			46	26		4		250		19	5			350		223		221
9cdal	DM	612	03-15-63			43	30		8		246		31	5		202		274	238		220
9cda	LG062	612	10-04-72			46	25	6.9	7.8	0.92	243		31	3.4	1.5				234	430	
9abbl	MJ	706	09-13-45		C	38	28		5		240		22	3.9			338		215		211
9abbl	DM	706	1962-3		C	38	28		30		244		21	4.0		200		258	253		216
9abb	LG061	716	10-04-72			43	26	9.4	10.7	1.3	247	12	21	5.9	2.2				229	424	
21cccl	MJ	8	09-13-45			55	29		3		274		31	2.8			394		256	467	256
23bbcl	MJ	560	10-25-44			46	26		4		250		19	5			350		223	442	222
23bbcl	DM	560	03-15-63			40	24		8		232		17	6		190		237	209		200
23bbc	LG113	920	06-08-73			39	24	10.3	11.6	1.3	239		20	6.2	2.9				221	417	
27aabl	MJ	605	10-23-44			44	27		8.9		247		23	8.8			358		233	420	219
27aabl	DM	605	1963			48	15		0		300		12	32		246		206	255		472
27aab	LG114	605	06-08-73			41	24	7.9	9	1.1	239		26	4.3	2.4				224	433	
20/60-24b	C	232	09-14-12	1.37	Δ	52	3		43		235		34	4	1.3			251	253		141
24adbl	HM	385	10-16-30	0.05	Δ	57	32				249		41	9.3				208	263		
24aaa	LG112	312	06-08-73			52	36	17.4	18.9	1.5	262		75	20	11.5				341	613	
20/61- 3dabl	MJ	242	05-01-41			54	15		24		237	tr	45	7		194	245		262		196
3dabl	M	300	10-16-56			48	23	6		1.1	232		34	4.9	1.5			249	233	421	
3dabl	DM	350	11-09-62			51	25		24		246		2	15		202		276	238		232
3dab	LG066	350	10-05-72			44	23	8.6	9.5	0.93	231		33	4.94	1.3				229	412	
4addl	HM	850	10-12-31	1.6		12	19		71		220		72	7.1				200	289		
4add	LG119	900	06-12-73			32	19	18.4	21	2.6	193		38	3.9	0.6				209	384	
13adcl	M	930	01-24-47			54	32		20		205		129	3.2	1			341	340	551	266
13adcl	DM	930	04-11-63			32	44		10		266		50	8		218		358	275		260
13adb	DRI	300	01-31-68			34	26		27		218		24	4.5			334		240	487	
13adb	LG117	300	06-08-73			36	37	221	24	2.4	251		69	17.8	1.9				309	549	
14dddl	M	402	01-24-47			46	27		0.9		226		35	3.5	0.8			225	224	424	226
15abl	M	1700	04-20-56			14	11	139	182	43	284		114	8	0.3			484	469	721	80
15bl	C		09-16-12	0.9	Δ	53	27		26		251		33	55				258	317		243
16bdbl	M	386	01-21-47			44	23		2.8		212		27	4.8	1.4			208	207	382	204
18ccl	MJ	412	02-16-45			46	26		12		212	21	30	5.3			352		245	434	222
18ccl	DM	412	11-26-62			56	76		23		288		5	5.8		236		243	307		176
18bcc	LG126	500	06-08-73			47	22	7.2	7.8	0.6	234		59	3.8	2				227	429	
19abdl	MJ	260	10-23-44			49	26		4.8		238		32	7.1			357		236	428	
19ddcl	MJ	280				48	26		8.7		242		34	6			364		242	432	224
19dda	LG121	295	06-08-73			48	22	7.0	8.6	1.6	235		36	3.9	2.2				236	434	

Appendix 4 (continued)

						Concentration of principal ions, mg/l											Dissolved solids mg/l				
Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation	Specific cond (umhos/cm)	Hardness (as $CaCO_3$)
20/61-20caa	DRI	300	01-31-68			104	82	68.3	76	8.1	335		457	30			1084		914	1180	
20caa	LG068	300	10-05-72			58	43	16.4	18.2	1.8	242		134	17.8	6.4				396	652	
20caa	LG067	665	10-05-72			55	32	9.7	11	1.3	234		72	13.3	3				301	519	
20caa	DRI	665	01-31-68		**	64	42	16.5	19.6	3.1	250		117	15.8			507		381	678	
20cacl	HM	347	09-15-44			44	14		33		237		30	10		194		240	248		167
20cacl	DM	347	11-26-62			80	0.97		0		305		5	63		250		237	299		204
20cab	LG069	400	10-11-72			63	42	16.2	18.1	1.9	258		134	14.5	5.1				403	664	
20dbcl	MJ	278	10-18-44			49	26		5.9		242		33	6.2			361		239	427	227
20ddcl	MJ	325	10-18-44			49	26		4.6		238		36	5.3			359		238		230
20ddcl	DM	325	11-26-62			37	19		16		298		20	31		244		263	270		172
21	M	125	07-21-52			164			190		243		417	136			1190		1026	1700	
22bbl	C		09-16-12	0.5	A	53	27		26		251		33	55	2		258		319		243
27	C	28	09-23-12			60	47		23		273		141	18	tr.			455	423		343
27cl	HM		08-31-25		Y	187	607		738		203		3839	288				6332	5760		
27cl	HM		08-31-25		Y	147	147		66	57	444		695	19.4				1462	1349		
27adbl	MJ				Y	78	21		9		249		61	22		204	323		313		281
27cddl	MJ	357	06-14-35			57	9		33		232		22	28		190	335		263		179
28cbdl	MJ	660	01-19-45			43	23		10		221		31	6			334		222	402	200
28cbdl	DM	660	12-14-62			54	27		34		216		11	5		218		260	237		248
28cdal	MJ	440	10-25-44		B	38	22		10		210		27	5			312		205	375	185
28cda	LG070	440	10-11-72			89	63	21	25	3.5	338		183	61	6.3				593	957	
28cdal	MJ	690	10-25-44		T	38	24		11		192	6	33	6			310		212		193
28cdal	DM	690	12-19-62		T	40	29		27		224		5	12		192		607	223		220
28dacl	MJ	640	01-19-45			46	22		6.7		171		24	11			280		194	335	203
28dacl	MJ	805	01-19-45			40	22		9.2		210		30	5.3			317		210	408	192
29cbc2	HM	600	02-03-32	1.1		64	20		7.9		233		58	5.5				235	270	557	
29cbc	LLL27	600	06-08-73			49	23	7	8.9	1.9	233		40	5.3	2.5				243	443	
29cbbl	HM	375	02-05-32	0.7		36	22		5.1		181		32	7.1				190	191	404	
29cccl	MJ		10-02-42			60	19		11		220		45	13		180	265		256		228
29dbbl	MJ	475	10-18-44			48	25		5.7		236		33	5.3			354		233	429	224
29dbbl	DM	475	1962-3		G	120	0		3.7		254		257	150		208		606	656		
29dcal	MJ	664	10-24-44			46	25		6.2		227		32	7.1			343		228	423	216
29dcal	DM	664	11-26-62			54	33		0		293		5	6.3		240		254	242		222
30dd	C		09-23-12	5.74	A	56	23		17		239		43	2	6			267	265		234
30bbbl	HM	350	03-27-31	1.1		51	24		7.6		249		38	tr.				247	243		227
30bbbl	DM	350	11-26-62			56	48		0		228		12	57		236		218	285		336

Appendix 4 (continued)

						Concentration of principal ions, mg/l										Dissolved solids mg/l					
Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation	Specific cond (umhos/cm)	Hardness (as $CaCO_3$)
20/61-31aad2	M	500	11-02-51			50	26				238		43	3.5	2.1				242	430	232
31dac1	M	940	05-16-52			48	25	8	11.6	3.6	222		51	6.5	1.			267	265	447	222
32acb2	MJ	660	02-16-45			46	25		11		235		40	7.1			365		245	441	220
33cca1	MJ	200			θ	46	28		9.2		233		44	8.8			369		251	447	229
33cca1	MJ	400			†	47	26		12		233		46	8.8			373		254	446	225
20/61-33cca	LG073	400	10-11-72			93	73	35	40	4.6	271		316	62	3.3				720	1074	
33cca2	MJ	226	02-21-38			84	tr.		32		270		47	7.0		221	280		303		210
33cca	LG122	226	06-08-73			44	26	7.3	10.7	2.4	225		46	4	2				242	438	
33ccb2	MJ	425				49	13		26		231	3.6	25	7.8			357		238	423	177
33ccb	LG072	425	10-11-72			92	95	80	91	11.1	292		457	73	4.9				956	1415	
34adc1	MJ	354	01-19-45			28	19		11		162		26	8.8			255		172	326	148
34adc1	LH	354	1962-3			53	4.9		33		300		24	46		246		301	308		152
34bcb1	MJ		06-14-41			84	25		50		305		144	16		250	460		469		312
34bcb1	DH		04-11-63			35	24		9		203		31	5		166		256	204		188
34bcb	LG074	780	10-12-72			42	21	7.6	9.9	2.3	209		37	6.7	1.9				221	397	
35cbb2	MJ	460	09-14-45			31	22		4		162	tr.	32	6			256		175	339	166
35cbb2	DH	460	12-19-62			40	29		18		224		6	14		184		148	217		220
35ccb	LG123	460	06-08-73			42	23	9	11.7	2.7	204		46	5.3	1.9				230	414	
35ddc2	MJ	418	09-14-45			39	26		5		206	tr.	40	3.2			319		214	377	205
36bbb1	MJ	325	01-19-45			44	26		10		233		36	7.1			356		238	424	216
36bbb1	DH	325	10-29-62			20	30		86		188	0.3	6	13		154		168	248		176
36bbb	LG063	325	10-05-72			43	25	7.9	9.6	1.7	235		39	5.9	2.2				239	438	
20/62- 1bbc1	M	1247	03-02-55			47	43	46	51	4.5	198		171	39	2			522	450	748	294
3bab1	M	504	10-16-56			46	23	7	8.8	1.8	232		32	4.5	1			248	229	413	230
4add1	MJ	800	05-05-41			60	17		13		246		34	12		200	255		258		220
4add1	M	790	10-17-56			43	23	10	22	3.8	252		25	5.8	2.4			272	245	440	201
4add	LG118	800	06-08-73			35	25	18.3	21	2.8	243		29	7.5	3.3				240	519	
8acd	DHI	120	12-31-67			32	35	15.1	19.3	4.2	258		26	4.9			374		243	483	
8acd	LG065	120	10-05-72			29	34	15.9	18.8	2.9	267		26	6.7	1.7				247	454	
9abc1	M	1000	10-17-56			39	19	91	98	7.1	228		162	18	0.7			486	449	728	176
9acc1	M	1000	10-17-56			38	25	49	55	5.8	256		88	8.6	0.9			399	341	575	199
18abc	DHI	300	12-31-67			26	46	11	14.1	3.1	278		34	3.8			402		261	520	
18abc	LG064	300	10-05-72			24	44	12	14.2	2.2	286		34	4.9	0.93				278	491	
19baa1	MJ		12-17-45			25	10		56		204		35	15		28	294		241		102
19bbb	LG116	289	06-08-73			26	34	27	31	4	249		48	8.3	1.1				270	486	
19cab1	MJ		12-17-45			39	15		84		221		110	32		181	408		389		159
19cab	LG115	200	06-08-73			24	29	15	16.8	1.8	200		37	7.3	1.8				214	399	
30	M	132	10-27-52			162			175		218		451	75			1050		970	1500	

Appendix 4 (continued)

Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Concentration of principal ions, mg/l											Dissolved solids mg/l			Specific cond (umhos/cm)	Hardness (as $CaCO_3$)
						Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation		
21/61- 1cba	LG075	400	10-12-72			23	20.2	11.6	15.5	3.9	165		35	4.4	1.6				181	335	
1cdc1	JR		01-21-47			49	26		3.9		223		47	3.5	1.3			241	240	428	230
2cbb1	MJ	1120	01-19-45			32	18		50		152		124	6.2			382		305	509	154
3a	C	442	09-23-12			54	25		10		251		39	19				318	261		237
3abb2	MJ		09-14-45		a	45	26		4.1		218	tr.	41	2.8			337		226	423	219
3abb2	MJ	807	09-14-45		T	40	23		5.5		199		39	3.2			310		209	398	196
21/61- 3ccc2	MJ	800	10-10-35			51	13		26		210		50	10		172	225		253		181
4aad1	MJ	793	01-19-45			41	23		17		223		37	9.6			351		237	418	197
4bad1	MJ	381	01-19-45			31	27		29		236		46	7.1			376		256	448	188
4baa	LG071	400	10-11-72			71	112	62	70	8.3	11.9		671	62	1.06				993	1380	
4dac1	MJ	810	05-19-41			60	18		3		220		32	10			228		230		
4dac1	DM	810	04-16-63			62	38		11		232		125	10		190		388	360		312
4dac	LG125	810	06-11-73			49	25	8.9	11.3	2.4	222		61	5.8	2.1				264	469	
4dac2	MJ	650	10-25-44			36	26		10		174	16	42	5.0			309		221	404	197
4dac2	DM	650	04-16-63			61	37		8		229		115	8		188		370	342		304
4dac	LG124	650	06-11-73			54	29	10.6	13.5	2.9	220		90	7.8	2.4				304	529	
4ddb1	MJ	400	10-09-45			60	17		2		1[illegible]		44	10		160	265		229		220
6acc1	JR	394	07-06-47			54	29		11		231		76	5.0	3.5			290	290	501	254
7acc1	MJ		03-15-45		a	49	25		7.1		212		51	5.3			372		254	458	236
7acc1	MJ	355	03-15-45		T	46	27		10		232		52	7.1			376		258	458	232
9acd1	MJ	550	10-17-44			45	24		11		223		39	8.8			350		237	424	212
10cda1	JR	931	04-13-53			143			521		95		1050	210			2100		1971	3000	
13bdb1	JR	260	01-21-47			60	29		10		227		71	2.5	2.9			278	287	485	268
15acc1	JR	892	01-23-47			47	25		4.1		211		47	3.8	1.4			233	232	420	220
15acc1	DM	892	1962-3			46	22		12		203		56	5		166		266	241		208
18dbd1	MM	300	09-10-30	0.3	i	68	32		12		243		109	10				329	350		
21bbb1	MJ	325	10-17-44			40	24		9.2		204		40	5.3			322		219	399	197
22ccc1	JR	500	01-06-47			65	32		7.8		227		106	7.0	4.3			334	334	560	294
23ccb1	JR		01-23-47			72	37		15		216		165	8.8	1.4			406	405	657	332
24aad	DRI	100	01-29-68			70	32	10	13	3	221		109	7.5			452		339	594	
24aad	LG078	100	10-13-72			178	108	115	120	5.1	261		741	157	11.2				1444	2006	
24aad	DRI	150	01-29-68			74	36	19.4	23	3.3	216		115	17.3			480		370	667	
24aad	LG077	160	10-13-72			98	56	42	45	2.6	242		302	57	6				682	1039	
25cab1	JR		01-20-47			139	51		7.4		218		357	14	2.3			678	678	1000	556
25cab1	DM		02-23-63			128	50		8		207		280	17		170		753	585		524
25cab	LG079		10-13-72			86	31	106	110	4.3	161		307	96	2.7				712	1120	
27cbb1	C	400	09-18-12			85	31		10		210		165	10	4			430	408		340
27ccc1	MJ	263	10-17-44			61	31		20		253		101	11			478		348	544	282
28d	MM	224	10-27-30	0.6	a	81	25		31		265		140	12.2				410	418		
28acc1	JR	176	03-06-43			72	21		18		220		116	3			400		338		266

Appendix 4 (continued)

Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Concentration of principal ions, mg/ℓ											Dissolved solids mg/ℓ			Specific cond (µmhos/cm)	Hardness (as $CaCO_3$)
						Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation		
21/61-29ddal	MJ	260	10-17-44			67	34		7.3		227		118	8.8			462		347	574	306
30a	HM		08-05-27	0.25		517	197		353		263		1735	601				3667	3535		
30d	HM	405	09-21-12	0.07		102	49		10		204		1278	15				617	554		
34	C		09-18-12	0.09		134	47		18		207		358	17	1.5			713	677		528
34abcl	M	246	01-06-47		θ	64	30		11		223		107	6	3.9			332	328	564	283
35dccl	HM	300	08-05-27	0.05	T	151	52		35		219		418	38				912	802		
21/61-35dccl	HM	485	08-05-27	0.05		116	39		42		168		358	22				745	660		
36adcl	M		01-20-47			137	56		22		205		392	29	2.4			740	739	1520	572
21/62- 3al	C		12-24-12		σ	58	38		34		254		110	11				545	376		300
3bbb	LG083	200	10-20-72			32	18.5	19.2	23	3.9	192		47	5.49	1.6				223	395	
4aaa2	HM	180	04-19-29			142	94		120		254		681	60				1306	1222		
5bb	C	546	12-24-12		Φ	500	150		1509		51	tr.	4008	658				7355	6850		1865
17ddcl	MJ	540	03-18-42			228	68		678		154		1599	378		126	3113		3027		849
17ddcl	DM	540	11-09-62			254	82		136		793		2060	390		650		3717	3312		972
19acdl	M		01-23-47			42	22		14		194		55	5.2	1.3			841	235	419	196
19acdl	M	114	05-20-57		λ	123	37		53		217		357	16			744		693	1025	
19acdl	DM	200	06-04-63			122	33		27		207		360	21		170		756	665		520
20dddl	MJ	458	12-21-42			66	20		25		144		134	15		118	371		331	1180	247
21dddl	MJ		07-13-42			246	98		765		78		2252	192		64	3705		3591		1017
27bcbl	MJ	525	07-13-42			148	46		511		81		1356	136		66	2360		2237		559
27bcdl	MJ	450	07-13-42			240	119		544		107		1678	308		88	3050		2942		1088
27cbal	MJ	420	07-13-42			158	45		504		81		1372	128		66	2388		2247		580
27cccl	HM	375	09-27-26			610	358		805		204		2855	1140				6378	5868		
27 ?	HM	500	03-21-33		σ	162	71		651		80		1735	169				2734	2828		
28aadl	MJ	420	07-13-42		Π	162	63		573		81		1600	161		66	2820		2599		663
28acdl	C		09-20-12		aγ	295	164		297		197	12	1233	417	0.5			2827	2515		1410
28adal	MJ	570	07-13-42			282	188		474		181		1641	460		148	3250		3134		1476
29bccl	MJ		08-04-42			64	34		11		181		147	16		148	420		361		299
29ccbl	MJ	700	07-13-42			79	39		33		195		232	20		160	580		499		357
29ccbl	M	1165	03-08-45			80	46		21		206		240	11			603		499	783	357
29cccl	MJ	404	07-13-42			110	50		29		215		327	20		176	715		642		480
29ccc	LG076	404	10-12-72			66	39	29	34.7	5.7	199		229	10.[illegible]	2				479	744	
29dbb	C		12-24-12		ξ	275	130		99		239		959	172	0.3			2102	1753		1220
29dbb	LW012		12-02-71		ξ	286	143	132	156	24	225		1137	168	2.1				2004		
30ac	C	405	09-21-12	0.08		102	49		10		204		278	15	0.75			617	555		456
30-	HM	500	03-04-25	0.2		282	172		500		165		1273	737				3303	3045		
30dbbl	MJ	390	08-04-42			110	42		18		160		315	20		131	602		584		447
30dbbl	DM	390	06-04-63			91	48		9		198		245	17		162		582	507		424
30dbb	LG082	390	10-17-72			106	53	24	30	6.5	212		358	17.7	2.4				672	891	
30dcbl	M	400	01-20-47			106	47		29		232		295	13		-		606	604	890	458
30dcbl	DM	400	05-22-63			120	56		26		207		360	26		170		810	690		528
30d	M	140	10-21-57			460			19		202		820	121			1670		1520		.

Appendix 4 (continued)

						Concentration of principal ions, mg/ℓ											Dissolved solids mg/ℓ				
Location	Source	Depth (feet)	Date Collected	Flow (cfs)	Remarks	Calcium	Magnesium	Sodium	Sodium & Potassium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Nitrate	Alkalinity	Total	Evaporation	Summation	Specific cond (µmhos/cm)	Hardness (as CaCO$_3$)
21/62- 31bdc2	MJ	600	07-13-42			147	50		8		158		392	37		130	805		712		572
31bdc	LG084	600	10-20-72			90	49	23	29	5.9	116		377	19	0.75				621	867	
34b	HM	375	09-27-26			610	358		805		204		2855	1140				6378	5868		
22/61- 1bcb4	DM		06-20-63		a	178	99		38		203		563	124		166		1490	1102		852
1bcb4	HM		09-25-30	0.25		161	56		65		226		473	69				924	936		
1bdb1	HM		09-25-30	0.25		229	94		128		182		901	107				1546	1548		
1b	HM		09-25-30	0.25		294	118		156		202		1148	142				1925	1957		
1d	HM	209	09-08-30	1.0		165	58		67		220		474	86				960	958		
1dac1	MJ	209	07-13-42			177	56		44		207		448	94		170	1018		921		672
1dac1	DM	209	1962-3			131	56		36		203		385	49		166		910	757		560
1dac1	LG081	209	10-13-72			171	61	57		14.6	207		437	104	2.7				949	1346	
2aba1	MJ	200	10-17-44			134	57		2.3		198		353	30			755		674	1090	568
2aba2	DM	200	06-20-63			134	70		2.2		190		400	33		156		855	733		576
3acc1	MJ		07-03-41			148	40		55		207		452	10		170	882		808		534
3acc1	DM		06-20-63			158	59		11		195		388	67		160		1007	779		640
3caa1	MJ	395	07-03-41			150	44		40		171		453	22		140	863		793		555
3dda1	MJ	335	06-15-45			158	53		0.7		176	9	441	0.5			838		749	1138	613
3dda	LG080	335	10-13-72			148	54	44	54	10.3	196		455	73	2.7				883	1269	
10bda1	C	305	09-18-12	1.18		155	60		15		205		405	35				857	761		592
10bda1	HM	305	10-13-30			166	55		57		220		479	64				1003	929		
10bda1	DM	305	06-20-63	1.15		178	57		45		198		450	100		162		1193	927		680
11bac2	MJ	175	03-28-45			140	52		25		202	tr.	404	24			848		744	1069	566
11bac3	C	412	09-17-12	0.71		177	56		47		215		483	67	1			1044	1151		672
11bcb4	C	100	09-17-12	0.67	=	193	73		104		191		597	168	4	-		1380	1219		782
12bbb1	MJ		10-17-44			120	51		58		157		414	52			851		772	1001	508
12bbb1	DM		06-20-63			126	53		0		203		255	20		166		786	554		536
12bbb	LG120		06-12-73			120	51	23	29	6.2	205		365	26	3.2				695	1016	
16a1	HM	65	09-07-26			188	51		102		329		326	205				1103	1036		
22/62- 1cba1	MJ	465	07-13-42			210	50		253		117		753	284		96	1800		1608		730
1cbc1	MJ	1135	03-15-45			106	20		436		84		1027	112			1785		1742	2480	347
1cbc1	DM	1135	03-14-63			240	24		64		110		1150	67		90		2065	1599		696
1cbc2	MJ		03-15-45		Y	120	31		536		323		932	254			2196		2032	2770	427
1cbc2	MJ	850	07-13-42			76	9		743		160		1296	256		131	2555		2459		227
1ccc1	MJ	300	09-24-45			174	85		378		102	tr.	513	700			1953		1900	3160	782
1ccc1	DM	300	12-19-62			203	30		269		234		145	540		98		2939	1302		684
9dcc1	MJ	180	11-09-42			98	56		124		176	tr.	279	218		144	943		862		475
12aac1	M	200	05-23-45			81	29		189		134		390	154			1010		909		321
12aac1	DM	200	1962-3			192	40		647		90		1400	394		74		2909	2717		644

EXPLANATION

A. Location

The locations and sequence numbers shown are generally identical to those in the source documents with exceptions noted in the remarks column.

B.

C	Carpenter (1915)
DM	Domenico and Maxey (1964)
DRI	Center for Water Resources Research, Desert Research Institute (unpublished)
HM	Hardman and Miller (1934)
LG075	Present study; Appendix 2 for description of sampling points
M	Malmberg (1965)
MJ	Maxey and Jameson (1948)

C. Measured or estimated discharge of flowing wells on the date of sampling.

D. Concentrations shown are mg/ℓ. Specific conductance is expressed as micromhos/cm. Values shown are rounded off as follows:

Reported concentration	rounded to
$n \leq 1$ mg/ℓ	nearest hundredth
$1 < n < 21$	nearest tenth
$n \geq 21$	nearest whole number

Total dissolved solids are expressed as "total", "evaporation" and "summation", with the latter calculated as the sum of the ionic constituents, after converting bicarbonate to carbonate. Concentrations expressed as "total" or "evaporation" are taken, as they appear, from previous reports.

Remarks

γ	Shallow well
Δ	Located in 20/60-24adb by Maxey and Jameson (1948).
δ	Incomplete analysis indicated by poor ion balance.
θ	Shallow flow (Maxey and Jameson, 1948).
T	Deep flow (Maxey and Jameson, 1948).
ξ	Grapevine Spring; located about 9 miles southeast of Las Vegas in 21/62-28 according to Hardman and Miller (1934), actual location 21/62-29dbb.
Π	Located in 21/62-28 by Carpenter (1915).
α	Located in 21/61-33bac by Maxey and Jameson (1948).
σ	Shallow well, 30 feet to water; located in 21/62-3b and 21/62-3a by Carpenter (1915) and Hardman and Miller (1934), respectively; latter location agrees with map presented by Carpenter.
Φ	Located in 21/62-5bb and 21/62-3bacl by Carpenter (1915) and Maxey and Jameson (1948), respectively.
Λ	E.M. Taylor ranch (Kyle or Park); located in 20/61-22b by Carpenter (1915).

λ Las Vegas Spring

Ω Low yield artesian well approximately 500 feet deep located "near Whitney, 8 miles southeast of Las Vegas" (Hardman and Miller, 1934).

** Stated to be 665' TD and located in 20/61-20da in 1968 (DRI) report.

ζ Originally reported 631' TD. Driller's log indicates 706' TD with 631' cased.

Ψ Located in 21/62-10cdd, by Malmberg (1965).

∞ Located in 22/61-1b by Carpenter (1915).

∂ Located in 22/61-1bd4 by Domenico and Maxey (1964).

⨍ Located in 21/61-8 and 21/61-18dbd, by Hardman and Miller (1934) and Maxey and Jameson (1948), respectively.

Appendix 5. Characteristics of Wells Used to Determine Historical Changes in Ground-Water Quality

Well #	Location T R S	Address	Depth (feet)	Cased (feet)	Perforated from - to	Date sampled	Remarks*
LG061	19/60- 4cda	Tule Springs Park	706	631	531 - 631	10-04-72	Original; sampled 09-13-45 (MJ), 1962-3 (DM); irrigation and domestic supply well; listed incorrectly in earlier reports as 631' TD
LG062	19/60- 9cda	Gilcrease Ranch	612			10-04-72	Original; sampled 10-23-44 (MJ), 03-15-63 (DM); irrigation well
LG063	20/61-36bbb	480 N. 25th St.	325	300	None	10-05-72	Original; sampled 01-19-45 (MJ), 10-29-62 (DM); artesian; domestic well
LG064	20/62-18bbc	3115 L.V. Blvd. No.	300	300	55 - 120	10-05-72	Original; sampled 12-31-67 (DRI)
LG065	20/62- 8aba	4229 L.V. Blvd. No.	120	120	70 - 115	10-05-72	Original; sampled 12-31-67 (DRI); reported as 200' TD in 1968 (DRI)
LG066	20/61- 3dab	Nellis AFB Well #2	350			10-05-72	Original; sampled 05-01-41 (MJ), 10-16-56 (MB), 11-09-62 (DM); public water supply
LG067	20/61-20caa	3087 W. Lake Mead Blvd.	665	570	394 - 570	10-05-72	Original; sampled 01-31-68 (DRI); deepened from 300' in 1947, flow increased to 0.2 cfs @ 665' TD
LG068	20/61-20caa	3001 W. Lake Mead Blvd.	300	75	None	10-05-72	Original; sampled 01-31-68 (DRI)
LG069	20/61-20cab	226 Anderson La.	400	400		10-11-72	Substitute for 20/61/20cac 1(MJ), 347' TD, sampled 09-15-44 (MJ), 11-26-62 (DM)
LG070	20/61-28cda	1531 W. Bonanza Rd.	440			10-11-72	Substitute for 20/61/28 cda1, (MJ) (shallow flow), sampled 10-25-44
LG071	21/61- 4baa	1823 E. Charleston Blvd.	400			10-11-72	Substitute for 21/61/4baa (MJ), 381' TD, sampled 01-19-45

Appendix 5 (continued)

Well #	Location T R S	Address	Depth (feet)	Cased (feet)	Perforated from - to	Date sampled	Remarks*
LG072	20/61-33ccb	2040 Goldring Ave.	425			10-11-72	Original; previously sampled in mid 1940's (MJ)
LG073	20/61-33cca	1824 Goldring Ave.	400	400	270 - 400	10-11-72	Substitute for 21/61/33ccal (MJ), 400' TD, sampled in mid 1940's, original well unperforated
LG074	20/61-34bcb	Union Pacific R.R. - Well #157	780	757	280 - 290 590 - 594	10-12-72	Original; sampled 06-14-41 (MJ), 04-11-63 (DM)
LG075	21/61- 1bba	2500 Boulder Hwy.	400	200		10-12-72	Substitute for 20/61/35ddc2 (MJ), 418' TD sampled 09-14-45
LG076	21/62-29ccc	4200 E. Russell Rd.	404			10-12-72	Original; sampled 07-13-42 (MJ), flows 0.005 cfs
LG077	21/61-24aad	3340 Rochelle Ave.	160	160	60 - 160	10-13-72	Original; sampled 01-29-68 (DRI)
LG078	21/61-24aad	3360 Rochelle Ave.	100	100		10-13-72	Original; sampled 01-29-68 (DRI)
LG079	21/61-25cac	5326 Topaz St.				10-13-72	Substitute for 21/61/25cabl (DM), sampled 01-20-47 (MB), 02-23-63 (DM)
LG080	22/61- 3dda	7117 Paradise Rd.	335		None	10-13-72	Original; sampled 06-15-45 (MJ)
LG081	22/61- 1dac	7044 Tomiyasu La.	209			10-13-72	Original; sampled 09-08-30 (HM), 07-13-42 (MJ), 1962-3 (DM), artesian
LG082	21/62-30dbb	5374 Sandhill Rd.	390			10-17-72	Original; sampled 08-04-42 (MJ) and 06-04-63 (DM)
LG083	21/62- 3cab	6000 E. Charleston Blvd.	200			10-20-72	Sampled to determine shallow water quality in an area reported to contain very high TDS

Appendix 5 (continued)

Well #	Location T R S	Address	Depth (feet)	Cased (feet)	Perforated from - to	Date sampled	Remarks*
LG084	21/62-31acc	6100 S. Pearl St.	600			10-20-72	Original; sampled 07-13-42 (MJ)
LG112	20/60-24aaa	4200 Smoke Ranch Rd. - Well #2	312	312	212 - 312	06-08-73	Substitute for 20/60/24adb (MJ), 385' TD, sampled 09-14-12 (C), 10-16-30 (HM)
LG113	19/60-23bbc	7000 Gilcrease Rd.	560			06-08-73	Original; sampled 10-25-44 (MJ), 03-15-63 (DM)
LG114	19/60-27aab	Ranch House Rd. & Tonopah Hwy.	605			06-08-73	Original; sampled 10-23-44 (MJ), 1963 (DM)
LG115	20/62-19cab	3725 E. Lake Mead Blvd.	200	200	None	06-08-73	Substitute for 20/62/19cab1 (MJ), sampled 12-17-45 (MJ)
LG116	20/62-19bbb	2342 N. Pecos Blvd.	289	289		06-08-73	Original; sampled 12-17-45 (MJ)
LG117	20/61-13adb	2934 L.V. Blvd. No.	300	300	60 - 300	06-08-73	Original; sampled 01-31-68 (DRI); 500' TD and 300'-500' perforated interval reported in 1968; driller's log indicates 300' TD and perforated 60'-300'
LG118	20/62- 4add	Nellis AFB - Well #1	800	800	90 - 784	06-08-73	Original; sampled 05-05-41 (MJ), 10-17-56 (DM)
LG119	20/61- 4add	4434 Craig Rd.	900	900		06-12-73	Substitute for 20/61/4add1 (HM), 850' TD
LG120	22/61-12bbb	2465 Warm Springs Rd.				06-12-73	Possible original; believed equivalent to 20/61/12bb1 (MJ), sampled 10-17-44 (MJ) 06-20-63 (DM)
LG121	20/61-19dda	800 Tonopah Hwy.	295	295	275 - 290	06-08-73	Substitute for 20/61/19ddc1(MJ), 280' TD

Appendix 5 (continued)

Well #	Location T R S	Address	Depth (feet)	Cased (feet)	Perforated from - to	Date sampled	Remarks*
LG122	20/61-33cca	716 Shadow Ln.	226			06-08-73	Possible original; believed equivalent to 20/61/33cca2 (MJ), 226' TD, sampled 02-21-38 (MJ)
LG123	20/61-35cbb	1201 Fremont St.	460			06-08-73	Original; sampled 09-14-45 (MJ), 12-19-62 (DM)
LG124	21/61- 4dac	Michelas Water Co. 244 St. Louis Well #1	650			06-11-73	Original; sampled 10-25-44 (MJ), 04-16-63 (DM)
LG125	21/61- 4dac	Michelas Water Co. 244 W. St. Louis Ave. Well #2	810			06-11-73	Original; sampled 05-19-41 (MJ), 04-16-63 (DM)
LG126	20/61-18bcc	2772 Tonopah Hwy.	500	500	300 - 500	06-08-73	Substitute for 20/61/18bcc (MJ), 412' TD, sampled 02-16-45 (MJ), 11-26-62 (DM)
LG127	20/61-29cbc	3333 W. Washington Ave.	600			06-08-73	Original; sampled 02-05-32 (HM)

*"Original" signifies a resampling in 1972 or 1973 or the same well sampled previously. "Substitute" indicates that the original well could not be located or was destroyed and that another well having the location and characteristics shown was used as a replacement. Previous sampling dates are shown, followed by initials to indicate the following data sources:

DM	Domenico and Maxey (1964)
DRI	Desert Research Institute
HM	Hardman and Miller (1934)
MJ	Maxey and Jameson (1948)

Appendix 6. Tritium Sampling Points and Analytical Results

Station*	Location	DRI Sample No.	Sample Date	Assay Date	Tritium Concentration (TU)†	Method of Analysis‡	Remarks
LW002	21/62-23bdb	574	May-June 1971	09-30-71	42.6 ± 2.2 42.1 ± 1.7	ES EG	Las Vegas Wash flow, primarily sewage
007	21/63-14daa	550	06-03-71	09-30-71	173 ±10	GC	Las Vegas Wash, total flow from all sources
009	21/61-13aba	601	06-21-71	09-30-71	21.9 ± 1.5 21.7 ± 1.4	ES EG	Flamingo Wash, spring flow
011	21/62-29dcd	554	06-11-71	09-30-71	5.5 ± 0.4	EG	Seepage north of Whitney Mesa
012	21/62-29dbb	556	05-31-71	09-30-71	2.9 ± 0.3	EG	Grapevine Spring
015	22/62-04bcc	555	05-31-71	09-30-71	28.7 ± 3.3 29.2 ± 1.2	ES EG	Seepage from underdrain beneath Sunset Rd.
015	22/62-04bcc	608	05-31-71	11-15-71	29.9 ± 1.2	1	Check sample
020	21/62-36cdd	576	May-June 1971	09-30-71	385 ±14	GC	Ground water return flow from BMI complex
022	22/63-07bca	573	May-June 1971	09-30-71	360 ±14	GC	BMI waste discharge to upper tailings ponds
027	21/62-22bbd	353	05-27-71	09-30-71	194 ±10	GC	Clark County STP outflow
030	21/53-28adb	583	05-31-71	09-30-71	349 ±18	ES	Pond adjacent to Las Vegas Wash near bedrock constriction
032	21/63-32bcd	557	05-31-71	09-30-71	411 ±14	GC	Ground water return flow from BMI tailings ponds
033	21/62-22ddb	1881	01-16-73	04-23-73	11.7 ± 0.5	EG	Shallow ground water at extreme east end of Tropicana Avenue
034	21/62-10cdd	605	06-29-71	09-30-71	76.0 ± 3.8 75.2 ± 3.0	ES EG	Las Vegas STP outflow
034	21/62-10cdd	607	06-29-71		69.9 ± 4.2 66.8 ± 2.8	ES EG	Las Vegas STP outflow; check sample
034	21/62-10cdd	552	05-27-71	09-30-71	17.4 ± 0.8	EG	Las Vegas STP outflow
048	21/63-31bba	572	May-June 1971	09-30-71	329 ±13	GC	Ground-water return flow from lower (BMI) tailings ponds
049	21/63-31bbb	575	May-June 1971	09-30-71	358 ±14	GC	"
057	17/59-34aab	578	06-14-71	09-30-71	4.8 ± 0.3	EG	Corn Creek Spring
058	22/58-02ccb	581	06-15-71	09-30-71	20.5 ± 0.9	EG	Bonnie Springs
059	21/62-19aaa	582	06-15-71	09-30-71	40.6 ± 2.1 40.6 ± 1.8	ES EG	Ground-water seepage from beneath Flamingo Reservoir

Appendix 6 (continued)

Station*	Location	DRI Sample No.	Sample Date	Assay Date	Tritium Concentration (TU)†	Method of Analysis‡	Remarks
LW060	21/61-12dac	602	06-29-71	09-30-71	23.7 ± 1.7 23.8 ± 1.0	ES EG	Spring discharge into Flamingo Wash
060	21/61-12dac	603	06-29-71	11-15-71	26.0 ± 1	1	
061	21/62-10cdb	604	06-29-71	09-30-71	68.6 ± 3.3	ES	Las Vegas STP inflow
061	21/62-10cdb	606	06-29-71	11-15-71	73 ± 3	1	
062	21/62-22bbb	609	06-29-71	09-30-71	205 ±12	GC	Clark Co. STP inflow
084	21/61-14adb	1908	01-28-73	04-23-73	35.6 ± 1.6	EG	Shallow ground-water discharge from a tile field beneath golf course
085	20/61-26cdc	1874	01-15-73	04-23-73	22.6 ± 0.9	EG	Shallow ground-water discharge from an underdrain beneath 15th St.
086	20/61-26cbd	1875	01-15-73	04-23-73	13.3 ± 0.6	EG	Shallow ground-water discharge from an underdrain beneath Maryland Pkwy. at Harris St.
087	21/61-02aaa	1876	01-15-73	04-23-73	98.9 ± 4.0	EG	Shallow ground-water discharge from an underdrain beneath Eastern Ave. at Ballard Dr.
088	21/61-01baa	1877	01-15-73	04-23-73	41.1 ± 1.6	EG	Shallow ground-water being pumped from underdrain below Montgomery Wards Dept. store
089	20/61-34aca	1879	01-16-73	04-23-73	125 ± 5	EG	Shallow ground water beneath El Cortez parking lot
090	21/61-10cca	1883	01-18-73	04-23-73	25.4 ± 1.0	EG	Shallow ground-water discharge from underdrain beneath Convention Center
091	21/61-20aad	1884	01-18-73	04-23-73	188 ± 7	EG	Shallow ground water pumped from elevator shaft pit of Dunes Hotel
092	21/61-09aaa	1885	01-18-73	04-23-73	21.1 ± 1.0	EG	Shallow ground water beneath Sahara Hotel
094	21/61-14bbc	1888	01-24-73	04-23-73	91.8 ± 3.6	EG	Shallow ground water pumped from basement of Sears Roebuck Dept. store
095	20/61-22dda	1889	01-28-73	04-23-73	9.5 ± 0.5	EG	Shallow ground-water discharge from an underdrain at Lake Mead Blvd. and I-15
096	20/61-27cac	1891	01-28-73	04-23-73	38.3 ± 1.7	EG	Shallow ground-water seepage from underdrains beneath UPRR trestle at Bonanza Rd.
097	20/61-31aac	551	05-28-71	09-30-71	3.3 ± 0.3	EG	Composite sample from LVVWD deep wells in main well field
LG002	22/62-01cba	580	05-31-71	09-30-71	4.5 ± 0.3	EG	Deep artesian well
006	21/63-28aca	565	06-07-71	09-30-71	301 ±15	ES	Piezometer (41 feet TD) adjacent to L.V. Wash
007	21/63-28aca	570	06-08-71	09-30-71	250 ±10 246 ±13	EG ES	Piezometer (134 feet TD) adjacent to L.V. Wash

Appendix 6 (continued)

Station*	Location	DRI Sample No.	Sample Date	Assay Date	Tritium Concentration (TU)†	Method of Analysis‡	Remarks
LG013	22/63-05cbb	558	06-08-71	09-30-71	285 ±12	EG	Piezometer (241 feet TD) in BMI (upper) tailings ponds
					287 ±15	ES	
017	21/63-31abb	1747	11-01-72	04-23-73	6.5 ± 0.3	EG	Piezometer (84 feet TD) adjacent to L. V. Wash
019	21/63-31bab	568	06-10-71	09-30-71	4.8 ± 0.4	EG	Artesian well (70 feet TD) (piezometer) between lower tailings ponds and L.V. Wash; discharge from Muddy Ck. Fm
026	21/63-07bcb	566	06-08-71	09-30-71	4.7 ± 0.3	EG	Piezometer (101 feet TD) below effluent ditch leading to upper tailings ponds
027	21/62-36baa	571	06-09-71	09-30-71	320 ±13	EG	Piezometer (62 feet TD) on western side of lower tailings ponds
					320 ±16	ES	
029	21/62-26dba	563	06-10-71	09-30-71	3.0 ± 0.3	EG	Artesian well (97 feet TD); discharge from Muddy Ck. Fm.
033	21/62-26dba	559	06-09-71	09-30-71	58.1 ± 2.9	ES	Piezometer (30 feet TD) completed in shallow sand and gravel deposits overlying the Muddy Ck. Fm.
					57.2 ± 2.3	EG	
035	21/62-15dda	546	06-10-71	09-30-71	5.4 ± 0.3	EG	Piezometer (102 feet TD) in flood plain of L.V. Wash below treatment plants and irrigated area
041	20/62-32aba	549	06-09-71	09-30-71	4.2 ± 0.3	EG	Piezometer (67 feet TD) in flood plain of L.V. Wash and above treatment plants
042	20/62-32aba	564	06-09-71	09-30-71	3.9 ± 0.3	EG	Piezometer (168 feet TD) in flood plain of L.V. Wash and above treatment plant
043	21/62-29dcd	569	06-11-71	09-30-71	2.9 ± 0.3	EG	Piezometer (56 feet TD) at north end of Whitney Mesa
044	21/62-29dcd	548	06-11-71	09-30-71	5.3 ± 0.3	EG	Piezometer (129 feet TD) at north end of Whitney Mesa
047	20/61-36ddd	567	06-09-71	09-30-71	3.4 ± 0.3	EG	Piezometer (97 feet TD) on west side of scarp crossing E. Charleston Blvd.
048	20/61-36ddd	561	06-09-71	09-30-71	4.2 ± 0.3	EG	Piezometer (48 feet TD) at same location as LG047
050	21/62-35dda	579	May-June 1971	09-30-71	212 ± 9	EG	Shallow ground water 2.3 miles north of BMI complex
					215 ±11	ES	

Appendix 6 (continued)

Station*	Location	DRI Sample No.	Sample Date	Assay Date	Tritium Concentration (TU)†	Method of Analysis‡	Remarks
LG055	21/63-29ccb	547	06-11-71	09-30-71	407 ± 13	GC	Shallow ground-water tributary to L.V. Wash in the vicinity of the BMI tailings ponds
056	21/62-11bcb	562	06-14-71	09-30-71	6.0 ± 0.4	EG	Deep ground water adjacent to L.V. Wash
057	20/61-03dab	585	06-15-71	09-30-71	4.5 ± 0.4	EG	Nellis AFB Well #2
058	20/61-15dcc	584	06-15-71	09-30-71	4.1 ± 0.3	EG	City of No. Las Vegas Losee Well
059	20/61-29ccc	560	05-28-71	09-30-71	4.3 ± 0.3	EG	LVVWD Well #34
061	19/60-04cda	577	06-14-71	09-30-71	5.1 ± 0.3	EG	Well at Tule Springs
093	21/62-30bda	1887	01-10-73	04-23-73	2.0 ± 0.3	EG	Artesian well in Paradise Valley
098	21/62-08dcc	2024	04-11-73	06-14-73	17.0 ± 0.8	EG	Shallow ground water adjacent to residential development using Colorado River water
099	21/62-09abb	2025	04-11-73	06-14-73	24.7 ± 1.1	EG	Shallow ground water below Winterwood Golf Course
100	20/61-35add	2023	04-11-73	06-14-73	30.9 ± 1.3	EG	Shallow ground water adjacent to an older residential development
101	21/62-21cad	2027	04-11-73	06-14-73	166 ± 7	EG	Shallow ground water adjacent to residential area served by Colorado River water
102	21/61-02bac	2022	04-11-73	06-14-73	53.0 ± 2.1	EG	Shallow ground water
103	21/61-01dcd	2021	04-11-73	06-14-73	45.0 ± 1.8	EG	Shallow ground water occurring in a zone of high permeability; possibly a buried wash
104	21/61-13bbc	2029	04-11-73	06-14-73	40.1 ± 1.6	EG	
105	21/61-23dab	2030	04-11-73	06-14-73	79.1 ± 3.2	EG	Shallow ground water adjacent to a residential area served by Colorado River water
107	21/61-26ccb	2031	04-11-73	06-14-73	36.0 ± 1.6	EG	*
108	21/61-08acd	2028	04-11-73	06-14-73	16.4 ± 0.8	EG	*
110	20/61-33cdb	2230	08-20-73	10-21-73	16.3 ± 0.7	EG	Shallow ground water beneath an old residential development served by local ground water
115	20/62-19cab	1704	10-05-72	06-14-73	6.4 ± 0.4	EG	Domestic well (200 feet TD)
128	21/62-15ccb	2026	04-11-73	06-14-73	107.8 ± 4.3	EG	Dewatering well (35 feet TD) in LDS Church farm area; fields irrigated with sewage
128	21/62-15ccb	2026	04-11-73	06-14-73	100.9 ± 4.1	EG	*; check sample
129	20/61-30ddb	1924	01-28-73	06-14-73	38.8 ± 1.6	EG	Shallow ground water adjacent to a residential area served by deep ground water from LVVWD
130	21/62-08aad	2224	08-02-73	10-21-73	55.5 ± 2.2	EG	Domestic well (90 feet TD) adjacent to Flamingo Wash
131	19/60-23add	2161	07-31-73	10-21-73	5.1 ± 0.3	EG	Well (400 feet TD) adjacent to Gilcrease Ranch

Appendix 6 (continued)

Station*	Location	DRI Sample No.	Sample Date	Assay Date	Tritium Concentration (TU)†	Method of Analysis‡	Remarks
LG132	20/60-19dca	2149	07-18-73	10-21-73	9.7 ± 0.5	EG	Very shallow ground water in an old residential area served by local ground water and septic tank disposal systems
LM213	21/64-19ada	586	06-17-71	09-30-71	333 ±13	GC	Lake Mead
LM214	21/64-19ada	587	06-17-71	09-30-71	321 ±12	GC	Lake Mead
LM215	22/64-03acd	588	06-17-71	09-30-71	372 ±13	GC	Lake Mead

* More complete sampling point descriptions are presented in Appendix 2.

† Tritium concentrations are expressed in tritium units (TU). One TU equals 1 H_3 atom in 1 x 10^{18} H_2 atoms.

‡ The following analytical methods were utilized by Teledyne Isotopes, Inc., Westwood, New Jersey:

ES Enrichment + liquid scintillation

EG Enrichment + gas counting

GC Direct gas counting without enrichment

1 Unspecified method of analysis made on certain check samples submitted to Dr. Gote Ostlund, School of Marine and Atmospheric Science, University of Miami, Miami, Florida